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THE DEMAND FOR PUBLIC STORAGE OF WHEAT IN PAKISTAN

Thomas C. Pinckney

December 1989

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FOREWORD

The governments of many less-developed countries are involved in the storage of staple foods. The most common justification for such storage is the presumed unfavorable effect on consumers and producers of year-to-year variability in production. In this report, Thomas C. Pinckney adds to IFPRI's long history of research on interannual supply stabilization issues by extending earlier analyses of Kenya, the Sahel, and other countries to Pakistan. Techniques developed in the Kenya research report are modified and expanded to clarify which types of trade and price interventions are most effective and efficient for stabilizing consumption.

In contrast to interannual storage issues, government's role in seasonal storage, including the effect of within-year price policy on the demand for public storage, is frequently neglected. This study, together with a recent report on Bangladesh, points out the importance of this component of storage for the size of government storage facilities and expected cost to the government. For Pakistan, this research demonstrates that relatively small adjustments in seasonal price policy have a much greater impact on fiscal cost and demand for storage facilities than the specified adjustments in interannual policies.

Research on these issues is continuing in southern Africa, where the interaction between supply stabilization policies of different countries in the region is the focus of analysis.

John W. Mellor

Washington, D.C.
December 1989

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Thomas C. Pinckney

1

SUMMARY

Many governments are concerned about stabilizing supplies and prices of staple foods to avoid shortages and political difficulties. This requires intervention in the market, most often through procurement and releases of the staples. Some amount of public stockholding is required, at least in the short term, in order to intervene effectively. This study develops a methodology for estimating the total demand for government storage from three different sources and applies the methodology to wheat in Pakistan. The analysis begins with a description of Pakistan's wheat economy and prospects for future growth of supply and demand. Expected growth is on the order of 3.3 percent per year, with the country remaining self-sufficient at prices that stay below import parity. The demand for storage should increase at approximately the same rate.

The study continues with a categorization of the different reasons why stocks may be held, and then proceeds to calculate the size of the three different components of stockholding. In the process, considerable insight is gained into the nature of efficient storage, trade, and price policies; trade-offs are measured between interannual price variability and fiscal cost and between the seasonal price spread and fiscal cost; and estimates are made of the minimum amount of stock that should trigger imports month by month. The resulting figure for storage capacity is highly sensitive to the size of the within-year gap between the procurement price and the release price.

The three reasons for government stockholding are to move wheat from surplus to deficit years; to move wheat from surplus to deficit seasons; and to ensure a smooth flow of supplies at all times, especially when imports are on order but not yet available domestically. These three components of storage policy can be termed interannual supply stabilization stocks, seasonal stocks, and import buffer stocks.

Interannual supply stabilization is commonly cited as the primary purpose of government stockholding. Production varies from year to year in ways that cannot be anticipated. Since Pakistan is self-sufficient in wheat at prevailing prices in a normal production year, production variability can lead to exportable surpluses in one year, followed by imports in the next year. The government loses money in such circumstances, since there are large differences between import and export parity prices. The government has the option, then, of storing some portion of an exportable surplus and releasing these stocks in deficit years.

Despite Pakistan's relatively low level of production instability, price variability would be fairly high in the absence of government intervention in the market. A nonintervention model estimates that harvest-time procurement prices would be higher than Rs95 per 40 kilograms in one out of six years, and lower than Rs65 in one out of six years. Given this rationale for government intervention, an optimizing model is built allowing for different relative preferences between the government objectives of lowering fiscal expenditure and lowering price and consumption variability.

Stabilizing supplies by holding stocks across years turns out to cost more money than it saves on average. Regardless of the degree of government preference for price stability, the *efficient policies do not hold interannual supply stabilization stocks unless the world price for wheat falls below US$80 per metric ton.*

Given the low likelihood of such a dramatic fall in world prices, the expected benefits of building additional storage capacity do not come close to paying for construction costs. Consequently, *no capacity should be added to government storage to accommodate interannual supply stabilization stocks,* although in years of abundant supplies and low world prices some stocks of this type could efficiently be held if storage space is available.

In addition to holding no stocks, the efficient policies allow some flexibility in official prices in response to changes in the world price and domestic production. Since fiscal expenditures fall as official prices become more flexible, there is a trade-off between the government's objectives of lowering expenditures and stabilizing prices. For example, a policy that holds harvest-time prices between Rs73 and Rs87 per 40 kilograms is expected to cost about Rs200 million (US$11 million) less annually than a policy that holds those prices between Rs78.90 and Rs81.10.

The second component of demand for public storage is for seasonal stocks. The size of public seasonal storage is dependent on the relative importance of the government and the private sector in moving wheat from harvest time to the months preceding the next harvest. A model of private storage behavior is developed to test the consequences of changing the gap between the procurement and release prices.

The average level of procurement in a normal production year is shown to be sensitive to government seasonal price policy. Government policy affects private storage primarily through its effect on the seasonal pattern of wholesale prices, and thus on price expectations within the crop year.

In the past, prices have risen about 18 percent from a low in May/June/July to a peak in December/January/February, or about Rs14.00 per kilogram at current prices. Using 1987/88 prices, if the government were to buy all that was offered at the procurement price and sell all that was demanded at the release price, the seasonal price rise would be limited to little more than Rs3.20. This could lead to decreased private storage and higher levels of procurement—and larger losses—by the government.

This concern would not be an issue if private storage were small or insensitive to expected changes in price. However, estimates in this report show that *private storage at the end of July has been no less than 5 million tons* for each of the last several years. Moreover, private storage has been quite sensitive to expected changes in price. A supply-of-storage model is developed and estimated showing that the larger the expected seasonal price rise, the more private agents in Pakistan have held in the past. Thus, it is reasonable to conclude that any government policy that lowers the expected seasonal price rise will increase government procurement.

Expected costs of a narrow gap between the procurement and release prices are high. On average *the government saves about Rs100 million annually and 100,000 tons of storage capacity for every 1 paisa per kilogram increase in the gap between the procurement and release prices.*

The third component of demand for public storage, import-buffer stocks, can be further broken down into two elements. First, stocks must be sufficient to allow for some wheat to be in transit and in godowns waiting to be sold without producing any supply disruptions. One month of expected offtakes for this component is more than adequate. Second, stocks must be sufficient to provide offtakes for four succeeding months if it is discovered that imports are required. To ensure that this component of demand is met, 3.5 million tons must be stored in early August.

Combining these three components of the demand for storage yields different levels of public storage capacity, depending on the gap between the procurement and release prices. With the 1987/88 gap of 8 paisa per kilogram, required capacity is 5.4 million tons in 1988, rising to 8.2 million tons in the year 2000. With a gap of 30 paisa, required capacity falls to 3.5 million tons in 1988 and 5.3 million tons in 2000.

Five policy changes are recommended in addition to the estimation of storage capacity. In order of importance, these are choosing a gap between the procurement and release prices that takes account of the large cost savings; holding no interannual supply stabilization stocks; introducing some responsiveness of official prices to production size; introducing responsiveness of official prices to world prices; and changing the law that allows the government to seize private stocks in an emergency.

Each of these changes would improve the efficiency of the wheat marketing system in Pakistan. The degree to which seasonal and interannual prices are allowed to fluctuate, however, will be based on the relative preferences of the government for reduced fiscal expenditures and price stability.

All these policy changes except the second—holding no interannual supply stabilization stocks—are relevant to other countries that intervene in cereal markets. Countries with higher levels of production variability are more likely to gain from holding interannual supply stabilization stocks than Pakistan. The other aspects of policy design, however, should hold qualitatively across countries.

2

INTRODUCTION

The Rationale for Storage

The price and availability of a country's primary staple food are of critical concern to its government. Rapid increases in price or periods of unavailability can lead to calorie deprivation, real-income declines, and political crises. Thus, most governments take measures to moderate price fluctuations and to ensure supplies through some intervention in the market.

If the government is to have an impact on prices or availability during a shortage, it is necessary to increase supplies reaching the market. This requires moving the commodity from surplus to deficit regions, or from surplus to deficit time periods. The surplus "region" may be the world market, with imports enhancing domestic supply. Often governments or parastatal organizations store, transport, and import or export the staple food for these purposes; alternatively, they may conduct policies that encourage the private sector to perform the activities.

Such activities are typically expensive for governments. Storage of foodgrains, in particular, requires both a high capital cost up front to build proper facilities and high costs each year to hold the stock (typically 15-25 percent annually of the value of the stock). Thus, there is a trade-off: more storage space and higher stock levels allow for more timely and effective government intervention, but both result in rapidly escalating costs. Basic economic principles imply that the degree of government involvement should stop at the point where the added security is not worth the added cost. The statement is simple; defining and measuring the added security and the added costs are quite complex.

Moreover, the problem with attempting to "buy" too much security is not limited to escalating fiscal costs. If the government is attempting to defend a price policy that it is fiscally unable to enforce, the result may be higher cost and higher actual price variability than would result from allowing some official price variability. There is some evidence that this was the case in Kenya in the early 1980s (Pinckney 1988b).

Estimating the economically efficient size of government storage facilities is one important component of limiting government cost. The calculation of such a number requires an analysis of the rationale for holding stocks. There are three reasons for some market agent—possibly the government—to hold stocks of grain:[1] to move supplies from a surplus *year* to a deficit *year;* to move supplies from a surplus *season* to a deficit *season;* and to avoid any disruption in supply, particularly while imports are on order but before they arrive in the country.

In short, these three rationales can be termed the interannual, seasonal, and import-buffer storage requirements. These three distinct demands on government storage can easily be confused, yet analyzing the requirements for each must remain distinct. General considerations for analyzing them will be considered in turn.

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[1] For another, similar analysis of the reasons for government storage, see Siamwalla 1988.

Interannual Supply Stabilization Stocks

The analysis of storage requirements for moving supplies from a surplus year to a deficit year is best begun by examining a simple identity.[2] For a particular year in any country, total supply must equal total demand. There are three possible sources of supply—production, opening stocks, and imports—and three possible sources of demand—consumption, closing stocks, and exports.[3] In equation form, this can be stated as

$$Q_t + S_{t-1} + M_t = C_t + S_t + X_t, \tag{1}$$

where

t = year,
Q = production,
S = closing stocks,
M = imports,
C = consumption, and
X = exports.

Solving for Q yields

$$Q_t = (S_t - S_{t-1}) + (X_t - M_t) + C_t. \tag{2}$$

That is, production equals the change in stocks plus net exports plus consumption.

Equation (2) implies that when production, Q_t, fluctuates from one year to the next, at least one of the three terms on the right-hand side will also have to fluctuate. In other words, production variability *must* be translated into stock variability, trade variability, or consumption variability.

A country that is an exporter in a normal production year can buffer production fluctuations by reducing exports, provided the production shortfall is less than its usual exportable surplus. Similarly, a country that imports in a normal year can increase imports in a bad year. The production shortfall could translate into tightness in the supply of foreign exchange—and if domestic prices are not at parity with world prices, or if the exchange rate is misaligned, the country may want to adjust domestic prices in order to decrease consumption during the shortfall. In neither the case of the importer nor that of the exporter, however, is it likely that stock changes will play any role in buffering such production fluctuations. The exporter would have to forgo exports in year t − 1 if it is to hold stocks for a possible shortfall in supply in year t. Thus, although holding stocks may allow the country to maintain exports in the face of the production shortfall in year t, the net effect is to move exports from year t − 1 to year t, while incurring a year's worth of storage charges. Such an operation would lose money unless there were a very large movement in world prices between the years. A similar analysis would hold true for the importing country.[4]

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[2] See Josling 1981 for a fuller discussion of this and other identities relating to food security.

[3] In this formulation, food aid is included with imports, public and private stocks are aggregated, and production is taken to be net of losses and seed.

[4] This paragraph assumes that the country is always an exporter, even in a bad year. A country such as Zimbabwe, which is an exporter of maize in a normal year but occasionally has a disastrous year and is forced to import, is more similar in this regard to a normally self-sufficient country.

The situation is considerably more complicated when a country is self-sufficient in a normal production year. This results primarily from the costs of engaging in foreign trade.[5] If a country could buy wheat in a deficit year at the U.S. Gulf Port price and sell in a surplus year at the same price, the situation would be the same as for the normal-year exporter. But for most cases, the export price is less than the U.S. Gulf Port price and the import price is more than that price. In many countries, the gap is quite large. For example, in Pakistan the difference between the import and export parity prices is about US$65 per metric ton.[6] Thus, if Pakistan has a surplus in one year and *knows* that it will be in deficit the next year, it is profitable to store the commodity for one year, since storage costs are about US$25 per ton.

The problem is that next year's crop is not known, and if the stock has to be stored for more than a couple of years, the government is losing more money than if it were to depend on imports. Thus, there is no obvious answer to the question of whether or not stocks for interannual supply stabilization should be held by a normally self-sufficient country.

The simple identity in equation (2), however, does provide at least three clues as to the general type of policy that will be most effective. First, *a "food security reserve" that ends every market year at the same level is totally ineffective* for stabilizing consumption when production is variable. In equation (2), it is the *change* in stocks that counteracts the shortfall in production. Thus, if stocks do not change, whether they begin and end the year at 0 or 3 million tons, *all* of the production decline will be translated into increased imports or decreased consumption. Such a reserve may act as an import buffer—the third type of storage requirement—but it does not stabilize consumption across years.

Second, *domestic price policy is intimately related to storage questions.* In equation (2), if domestic prices are allowed to change in response to fluctuations in production, consumption will change, leading to less need for stock or trade variability. The extent to which domestic consumption varies with domestic production is thus important in the formulation of a storage strategy.

Finally, *trade variability and stock variability can be substitutes for each other.* Thus, a country can stabilize consumption by depending totally on trade or mostly on stock changes to make up for production surpluses and shortfalls. For a wheat-consuming country, the choice between relying on one or the other should be based purely on cost after accounting for any misalignment of the exchange rate (recall that stocks to cover the delay between ordering and receiving imports are analyzed separately), as consumers have no clear preference for domestic wheat or imported wheat and the international market for wheat functions well. It is likely that the relative costs of relying on trade or stocks will vary with the world price. For white-maize-consuming countries, the situation is complicated by a preference for the domestic commodity compared with the internationally traded commodity.

Given these clues, then, the question is how much domestic prices should adjust to a production deviation, thereby allowing consumption to vary with production. Of the remaining production variability, how much should be assigned to stock variability and how much to trade variability?

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[5] For countries where the staple food is rice or white maize, the thinness of the international market is another consideration.

[6] All tons in this report are metric tons.

The answers to these questions depend on the characteristics of the country in question. One particularly important parameter is the degree of willingness of the government to spend fiscal resources to stabilize consumption. These issues are discussed in detail in Chapter 3.

Seasonal Storage

Even if a government holds no interannual stocks, there may be a need to hold seasonal stocks if the seasonal price variability in the absence of intervention is undesirably high. There is reason to believe, however, that once a government begins to involve itself in seasonal storage, the demand for storage capacity could increase dramatically. A government that holds 10 percent of its normal production across years will cover the vast majority of shortfalls in annual production; if all production takes place in one quarter, however, a government would have to hold 75 percent of annual consumption to cover the "shortfall in supply" during the last three quarters of the year. Thus, it is likely that the primary demand for public storage will result from seasonal considerations.

Equation (2) can be generalized to make it appropriate not only to years but also to seasons. Distinguishing between private and public stocks is necessary in this context, since many private agents, including producers, hold seasonal stocks. If time period t is considered to be, say, quarters of the marketing year, after isolating consumption on the right-hand side the equation becomes

$$Q_t + (SG_{t-1} - SG_t) + (SP_{t-1} - SP_t) + (M_t - X_t) = C_t, \qquad (3)$$

where

SG = government stocks,
SP = private stocks, and
$Q_t < Q_1$ if $t = 2, 3,$ or 4, defining quarter 1 as the primary harvesting quarter.

The equation shows that consumption equals this quarter's production plus the net decline in government stocks plus the net decline in private stocks plus net imports. The same identity holds for the annual case, the main difference being the extreme production instability, which is known ahead of time in the quarterly case. If all of the harvest takes place in the first quarter, for three quarters all consumption comes from stock drawdowns or imports.

The equation provides three important insights into the nature of seasonal stocks. First, as in the annual case, stock variability and trade variability are substitutes. The rationale for holding stocks is much stronger in the seasonal case, however, since it is known that no production will take place for three quarters and since the lag between ordering and receiving imports will be at least one full quarter. Nevertheless, a country that is a normal-year importer can reduce domestic storage costs considerably by timing imports to coincide with the preharvest period.

Price policy has a greater effect on seasonal storage than on interannual storage because of the increased importance of private stocks. Private stocks should respond to changes in expected prices. A government policy that involves increases in government stocks and decreases in the seasonal price rise may actually *lower* total stocks if the price effect on private stocks is greater than the additional government stocks. In addition, allowing seasonal prices to increase has the same effect as in the interannual case of decreasing consumption during the scarce months.

The second point to be made from the equation is the trade-off between private and public stocks: if private agents do not store wheat, all seasonal storage will have to be conducted by the government. Thus, seasonal storage issues have the potential to be extremely costly for the government in terms of operating costs and storage-space requirements.

The final point is an obvious one: seasonal storage demand is seasonal. The peak for this type of storage is immediately after the harvest, while the minimum is virtually zero immediately prior to the harvest. To the extent that the other two reasons for holding stocks have seasonal components, total storage capacity required by the government is likely to be less than the sum of the maximum requirements for each of the three types of stockholding. Thus, it will be necessary to consider the storage requirements on a monthly or quarterly basis in order to estimate accurately the total demand for government storage.

Storage for Avoiding Disruptions in Supply

This type of storage is composed of amounts that are required at any one time to be in transit or in regional stores, and the amount necessary to allow for the delay in the arrival of imports when they are necessary. Since the latter requirement is likely to be the largest in most months, the term "import-buffer stocks" is appropriate and will be used here. In some analyses, this component of storage is termed "working stocks," but that term can be confusing, since it is also used for seasonal storage in many papers.

The key questions are these: How long does it take the government to make a decision to import, including the allocation of foreign exchange? Once ordered, how long is the delay before imports arrive, are unloaded, and are available? What is the distribution of net offtake from government stocks for different months?

The last question indicates that this component of storage, like the seasonal stock component, will vary by month. Unlike the other components of storage, however, little can be said about this component before examining empirical data. This empirical analysis is presented in Chapter 5.

Storage Demand for Wheat in Pakistan

Wheat is the staple food for the vast majority of Pakistan's population, contributing almost 50 percent of total calories. The government has been involved in the wheat market for many years through procurement and release policies. Prior to planting time, the government announces a procurement price that will be effective at harvest time. Farmers are free to sell to the government at the procurement price or to private agents at any other price.

From World War II until 1987, the primary mechanism for the government to release wheat was through the ration shop system. The system was subject to much abuse and was replaced in March of 1987, with the government promising to release all of the wheat demanded at a set price (see Alderman 1988b). These policies clearly imply an important role for government storage, both within and between years.

In addition, the government controls all official foreign trade in wheat and wheat products. Although some unofficial trade in wheat takes place, these amounts are necessarily small. Thus, the government has chosen to play a major role in marketing, trading, and storing wheat.

Escalating costs and the recent change in policy toward releases have contributed to the need to understand the rationale for storage and to explore various ways of bringing the costs of wheat policy in line with the benefits of government involvement. Thus, Pakistan is a useful case study in which to analyze the demand for public storage.[7]

Chapter 3 briefly summarizes Pakistan's wheat economy and includes an examination of the primary agroclimatic zones for wheat production, a forward look at the future of Pakistan's consumption and production of wheat, and a backward look at the historical instability of wheat production. Chapters 4, 5, and 6 examine the demand for interannual supply stabilization stocks, seasonal stocks, and import buffer stocks, respectively. The final chapter draws conclusions for Pakistan and other countries concerning the demand for public storage.

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[7] Public storage of other cereals produced and consumed in Pakistan—maize, millet, sorghum, barley, and rice—is not considered in this study. The government does not purchase the first four, and thus does not engage in public storage of them. Rice is an export crop, and thus requires a very different type of analysis. Furthermore, since rice consumption is less than one-fifth of wheat consumption, and since rice calories are considerably more expensive than wheat calories, it is unlikely that rice plays an important role in buffering supply instability of wheat, particularly for poor consumers.

3

THE SETTING OF PAKISTAN'S WHEAT ECONOMY

In order to assess the demand for public storage of wheat, it is necessary to understand the basic structure of wheat production in Pakistan. This chapter opens with a summary of the agroclimatic zones where wheat is grown, followed by brief sections on government intervention in the wheat market and supply responsiveness of wheat production. Trends in production for the country as a whole and by zone are summarized, and expected growth in consumption is examined. This is followed by an estimate of future growth in wheat production and consumption given price adjustments implied by trends in production and consumption of other major agricultural commodities. The final section considers the historical production instability.

The Structure of Wheat Production in Pakistan

Agriculture accounts for about one-fourth of Pakistan's gross domestic product (GDP), with wheat production accounting for just over one-fourth of agriculture's value added. Livestock products contribute 30 percent of agriculture's value added, with most of the rest produced by cotton, rice, and sugarcane. More than one-third of cropped acreage is planted to wheat.

The major agricultural areas of Pakistan lie in the Indus basin. Of the 31 million hectares considered suitable for cultivation, more than 20 million are cultivated; about 14 million of these cultivated hectares are in the Indus Plains. This area supplies more than 80 percent of agricultural production.

Most parts of the Indus Plains do not receive enough rainfall to support agriculture. They are exceptionally flat, however, providing some of the best land for gravity-fed irrigation in the world. During the last 130 years, more than 40,000 miles of canals have been built.[8] More recently, more than 200,000 private and public tubewells have begun to supplement canal irrigation. About 85 percent of wheat production takes place under irrigation, leaving only 15 percent for the rainfed *(barani)* areas.

There are two main cropping seasons in most of Pakistan: *kharif* (April to November) and *rabi* (November-April). Cotton, rice, maize, millets, sorghum, and sugarcane[9] are the major *kharif* crops, while wheat, oilseeds, gram, and barley are the major *rabi* crops. Of the total cropped area, 55 percent is planted in the *rabi* season and the rest in the *kharif* season. There are large interregional differences, however; in the Sind, only 42 percent of cropped land is planted in the *rabi* season.

The cropping patterns and rotations vary in different parts of the Indus Plains. Therefore, it is useful for purposes of this study to divide the country into agroclimatic zones.[10] Since wheat is the predominant crop in the *rabi* season in virtually all areas, the primary *kharif* season crop becomes the basis for differentiating the zones. In the irrigated areas the two most important *kharif* crops are rice and cotton. In areas of high water table, heavy soils, and greater rainfall, rice tends to dominate, while in the drier areas cotton is generally planted. Thus, one major division is between areas suited to rice and areas suited to cotton. Since growing conditions vary significantly as one moves from north to south, there are four distinct cotton or rice zones: cotton/wheat Sind, cotton/wheat Punjab, rice/other Sind, and rice/wheat Punjab.[11]

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[8] For a fascinating account of the development of the irrigation system and the effect of partition on the system, see Michel 1967.

[9] Since sugarcane is sown in spring and harvested in winter, it is considered a *kharif* crop, but generally a second ratoon crop is also taken and therefore, in practice, it occupies the land for both seasons.

There is one zone centered around Faisalabad in which conditions are suitable for a number of *kharif* crops, with no single crop dominating. This will be termed the "mixed zone." The *barani* areas are considered distinct because of their dependence on rainfall. Finally, the area close to the left bank of the Indus in the Punjab, which has relatively less-developed irrigation facilities and thus low cropping intensities, is considered a separate zone. This makes a total of nine zones. Five are in the Punjab: rice/wheat, cotton/wheat, mixed, *barani,* and low-intensity. Two are in the Sind: rice/other and cotton/wheat. Because of similarities in cropping patterns and climate, D. I. Khan District of North-West Frontier Province (NWFP) is included in the low-intensity zone of the Punjab, and Nasirabad District of Baluchistan is in the rice/other zone of the Sind. The remaining districts in NWFP and Baluchistan make up the final two zones. Districts included in each zone are listed in Table 1, and a map of the zones is presented in Figure 1. Although the other districts in NWFP and Baluchistan are not homogeneous agroclimatically, it is not worthwhile to disaggregate them since they compose only 6.3 percent and 1.2 percent of wheat production, respectively. The contribution of each of the nine zones to total wheat production over the last 18 years is presented in Table 2, along with the average yield for wheat during that period.

Government Policy Toward Wheat

The government of Pakistan has intervened in the wheat market for decades.[12] Wheat was rationed in the urban areas during World War II as an emergency measure; after the war, markets for most commodities were freed, but the government continued to ration wheat and sugar. The ration system was changed to a partial provisioning system in the 1960s, with the government supplying less than the normal household requirements at the subsidized, ration-shop price. Wheat flour was also available at considerably higher prices on the open market.

Until the mid-1960s, most of the wheat in the ration shops was received as food aid. Two events caused a major change in the system. First, the war with India at this time led to a halt in U.S. PL480 shipments to both countries, during a time when domestic supplies were scarce. Second, the beginnings of the "green revolution" in 1967 and 1968 caused the country to move close to self-sufficiency in wheat production. Thus, in 1968 the government procured a large proportion of the wheat crop for the first time.

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[10] The zones used here are based on but are not identical to those used in the PARC/CIMMYT (1986) report.

[11] Sind, Punjab, North-West Frontier, and Baluchistan are the four provinces of Pakistan.

[12] See Alderman, Chaudhry, and Garcia 1988 for a fuller explanation of government policies toward wheat consumption, and Cornelisse and Naqvi 1984 for a fuller description of wheat marketing.

Table 1—Districts of Pakistan, by agroclimatic zone

Zone[a]	District
Rice/wheat Punjab	Sialkot
	Gujrat
	Gujranwala
	Sheikhupura
	Lahore/Kasur
Mixed Punjab	Sardogha/Khushab
	Jhang
	Faisalabad/T. T. Singh
	Okara[b]
Cotton/wheat Punjab	Sahiwal[b]
	Bahawalnagar
	Bahawalpur
	R. Y. Khan
	Multan/Vehari
Low-intensity Punjab	D. G. Khan/Rajanpur
	Muzaffagarh/Leiah
	Mianwali/Bhakkar
	D. I. Khan
Barani Punjab	Attock
	Jhelum
	Rawalpindi/Islamabad
Cotton/wheat Sind	Sukkur[b]
	Khairpur
	Nawabshah
	Hyderabad[b]
	Tharparkar
Rice/other Sind	Jacobabad
	Larkana
	Dadu
	Thatta
	Badin[b]
	Shikarpur[b]
	Nasirabad[b]
	Karachi[b]
Other NWFP except D. I. Khan	
Other Baluchistan except Nasirabad	

[a] Punjab, Sind, North-West Frontier Province (NWFP), and Baluchistan are the four provinces of Pakistan. Because of cropping and climate similarities, the D. I. Khan District of NWFP is included in the low-intensity zone of the Punjab and the Nasirabad District of Baluchistan is included in the rice/other zone of the Sind.

[b] These districts were divided or created after 1967/68.

Since 1973/74, procurement has averaged just under one-fourth of production, ranging from 13 to 36 percent of the crop (Table 3).[13] The government typically announces a procurement price at planting time; this price occasionally has been adjusted upward a month prior to harvest. There is an active private trade in wheat that is regulated but not controlled by the government.

Usually, farmers have been free to sell wheat to private agents or to the government procurement agency. Until recently, however, the law did not allow private agents to

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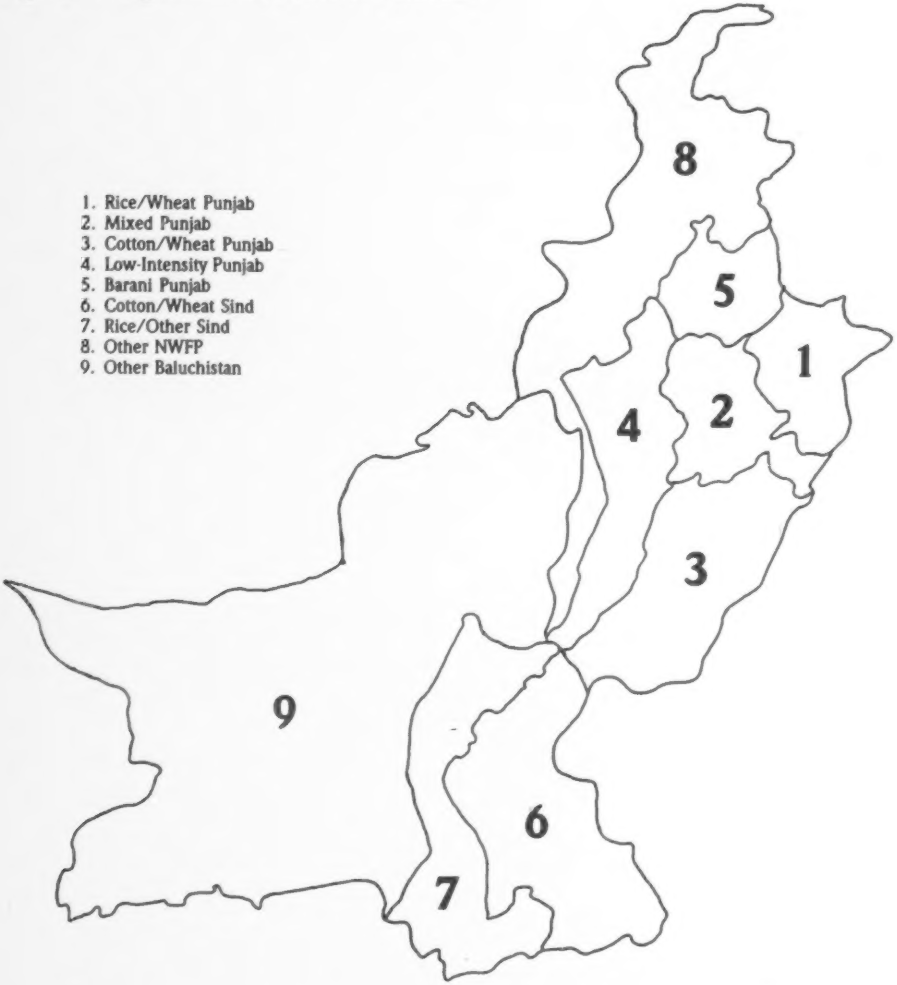
[13] See Pinckney 1989 for an analysis of the determinants of procurement size.

Figure 1—Agroclimatic zones of Pakistan


1. Rice/Wheat Punjab
2. Mixed Punjab
3. Cotton/Wheat Punjab
4. Low-Intensity Punjab
5. Barani Punjab
6. Cotton/Wheat Sind
7. Rice/Other Sind
8. Other NWFP
9. Other Baluchistan
8
5
1
4
2
3
9
6
7

Note: Punjab, Sind, North-West Frontier Province (NWFP), and Baluchistan are the four provinces of Pakistan.

transport wheat out of surplus areas during the harvest months. This law lowered the price in those zones and made the procurement price more attractive. In addition, there are allegations that in years of scarcity, particularly in the 1970s, some farmers were forced against their will to sell wheat to the government at the procurement price.

The relationship of the procurement price to the world price has gone through several stages.[14] From the late 1960s until the 1972 rise in world prices, the procurement price was higher than import parity at the official exchange rate. Such policies

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[14] See Hamid et al. 1987 and Dorosh and Valdés 1989 for a discussion of these issues.

Table 2—Average shares and yields of Pakistan's wheat production, by agroclimatic zone

Zone[a]	Share, 1968 to 1985	Yield, 1981 to 1985
	(percent)	(metric tons/hectare)
Other Baluchistan	1.2	1.14
Barani Punjab	4.0	0.94
Rice/other Sind	4.3	1.56
Other NWFP	6.3	1.14
Low-intensity Punjab	10.2	1.29
Cotton/wheat Sind	12.8	2.16
Rice/wheat Punjab	16.5	1.53
Mixed Punjab	20.3	1.87
Cotton/wheat Punjab	24.3	1.83

Source: Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).

[a] Baluchistan, Punjab, Sind, and North-West Frontier Province (NWFP) are the four provinces of Pakistan.

were possible since the government had (and continues to have) monopoly control of wheat imports and exports. From 1972 to 1976, the procurement price was lower than export parity; since that time, the procurement price has tracked export parity rather closely, moving to a level between import and export parity in 1986 and 1987. Since Pakistan has been approximately self-sufficient in wheat during the 1980s, the more recent price regime seems reasonable. When adjustments are made for exchange rate and trade policies, however, the recent procurement prices fall well short of export parity (see Dorosh and Valdés 1989).

On the consumption side, the government dismantled the partial provisioning system for sugar in 1983 and for wheat in 1987. To assure consumers that wheat flour prices will not skyrocket, the government guarantees that it will sell at a certain price all the wheat that is demanded. The implications of this system for procurement and government cost are examined in Chapter 5.

Table 3 presents the results of these policies on government procurement, offtake, imports, and stocks. There are clearly some data problems, since computed closing stocks (equal to opening stocks plus procurement plus net imports minus offtakes) fail to equal actual closing stocks. The problems are most likely with the stocks data, since different sources present conflicting numbers. Nevertheless, it is clear that interannual stockholding has increased in recent years. The costs of such a policy, and possible methods for lowering these costs, are examined in subsequent chapters.

Supply Responsiveness of Wheat

Relative prices play an important role in the allocation of resources within agriculture and between agriculture and nonagriculture. This section attempts to measure the responsiveness of wheat production to relative price changes. Since the specific cropping pattern would be expected to have an effect on price responsiveness, equations are estimated by zone, with the total supply response an aggregation of the zonal estimates.

Linear equations for both yields and areas are estimated for each zone. Estimated equations are given in Appendix 1 (Tables 27 and 28) and results are reported in detail in Pinckney 1989. Table 4 presents the implied elasticities at the mean.

Table 3--Wheat production, stocks, procurement, offtake, and imports, 1970/71-1986/87

Year	Production from Previous Year	Opening Stocks	Procurement	Offtake	Net Imports	Computed Closing Stocks	Actual Closing Stocks
				(1,000 metric tons)			
1970/71	7,294	33	1,017	1,196	269	123	165
1971/72	6,476	165	841	1,323	439	122	42
1972/73	6,890	42	265	1,588	1,418	137	132
1973/74	7,442	132	1,292	2,210	1,079	293	75
1974/75	7,629	75	1,265	2,296	1,173	217	75
1975/76	7,673	75	1,333	2,322	1,273	359	389
1976/77	8,691	389	2,252	2,759	505	387	440
1977/78	9,144	440	1,850	2,880	822	232	85
1978/79	8,367	85	1,093	2,977	2,112	313	236
1979/80	9,950	236	2,402	2,744	668	562	632
1980/81	10,587	632	3,043	2,768	20	927	997
1981/82	11,476	997	3,926	3,214	101	1,810	1,727
1982/83	11,304	1,727	3,132	3,115	−53	1,691	1,702
1983/84	12,414	1,702	3,826	3,251	−191	2,086	1,855
1984/85	10,882	1,855	2,505	3,695	544	1,209	1,047
1985/86	11,703	1,047	2,487	3,477	1,482	1,539	1,258
1986/87	13,940	1,258	5,073	3,648	80	2,763	2,876

Sources: Data originate from provincial food departments, but were collected from the Ministry of Food, Agriculture, and Cooperatives, Islamabad; also, Pakistan, Ministry of Food, Agriculture, and Cooperatives, Planning Unit, Early Warning System Project, *Wheat Situation Report,* various issues (Islamabad: Government Press, various years).

Notes: Opening stocks are given as of May 1. Procurement, offtake, and imports are summed from May 1 to April 30. Since procurement in the Sind begins in April, some of the wheat included in the procurement statistics actually is from the next year's crop. This also causes the procurement statistics in this table to differ from most other series, which are usually given for April-March. It would have been preferable to present all series for April-March; however, stocks for the Pakistan Agricultural Supply and Storage Corporation (PASSCO) are only available for May 1 of some years, and offtake in Azad Kashmir and net imports are only available on an annual, May-April basis for most years. Computed closing stocks are calculated as opening stocks plus procurement and net imports, minus offtake.

In some of the area equations, expected gross revenue from wheat production is used rather than the price of wheat. If expected yields are not changing, the effect of an increase in price is interpreted as if the parameter were estimated with the price of wheat. Using expected revenue makes for more accurate estimation if relative yields have been changing rapidly over time.

Area exhibits a wide range of response values to the price of wheat. The weighted average area elasticity for all Pakistan is 0.09 in the short run, about 0.20 in the long run. The highest short-run response was for other Baluchistan at 0.31, while the two Sind zones have negative area response to price (neither of these is significantly different from zero). Yield responses are much closer together; most of the results are between 0.29 and 0.57. The weighted average for all Pakistan is 0.34, implying a total short-run response to price of 0.43 (area plus yield). This is fairly high for a staple crop in a less-developed country.

The price of fertilizer has a negative effect on area in several zones, as the weighted average of all zones is −0.06. Cotton had the only cross price to affect wheat production significantly in these equations, with significant negative effects on yields in the two cotton/wheat zones. This is reasonable, since wheat is planted after cotton, and a higher cotton price increases the incentive to leave the crop in the ground longer. This delays wheat planting past the optimal date, however, thus decreasing wheat yields.

Table 4—Wheat supply elasticities with respect to prices, by agroclimatic zone

	Own Price			Fertilizer Price, Area	Cotton Price, Yield
	Area				
Zone[a]	Short Run	Long Run	Yield		
Rice/wheat Punjab	0.25***	0.39***	0.57*	...	...
Mixed Punjab	0.04	0.21	0.43**	−0.09**	...
Cotton/wheat Punjab	0.03	0.11	0.29**	−0.06	−0.14**
Low-intensity Punjab	0.16*	0.32*	0.57*	−0.11	...
Barani Punjab	0.21***	0.31***	0.15***	...	...
Rice/other Sind	−0.02	−0.04	0.41	−0.11	...
Cotton/wheat Sind	−0.04	−0.04	−0.07	−0.12*	−0.08**
Other NWFP	0.20**	0.38**	0.33	...	...
Other Baluchistan	0.31***	0.40***	0.08	0.25	...
All Pakistan[b]	0.09	0.20	0.34	−0.06	−0.04
All Pakistan[b]	0.08	0.14	0.32	−0.03	−0.04

Note: All area elasticities, except those for *barani* Punjab and rice/other Sind, were estimated with *expected* revenue instead of price.

[a] Punjab, Sind, North-West Frontier Province (NWFP), and Baluchistan are the four provinces of Pakistan.

[b] The first "All Pakistan" line presents weighted averages of the elasticities for the individual zones. The second "All Pakistan" line also presents weighted averages, but in this case all elasticities not significantly different from zero at the 90 percent level are assumed to equal zero.

* Denotes 90 percent confidence level.

** Denotes 95 percent confidence level.

*** Denotes 99 percent confidence level.

There was an insignificant positive effect of cotton price on wheat area, which may result from some farmers increasing their wheat area to meet subsistence needs when they know that late planting due to additional cotton picking will reduce their wheat yields.

Trends in Wheat Production

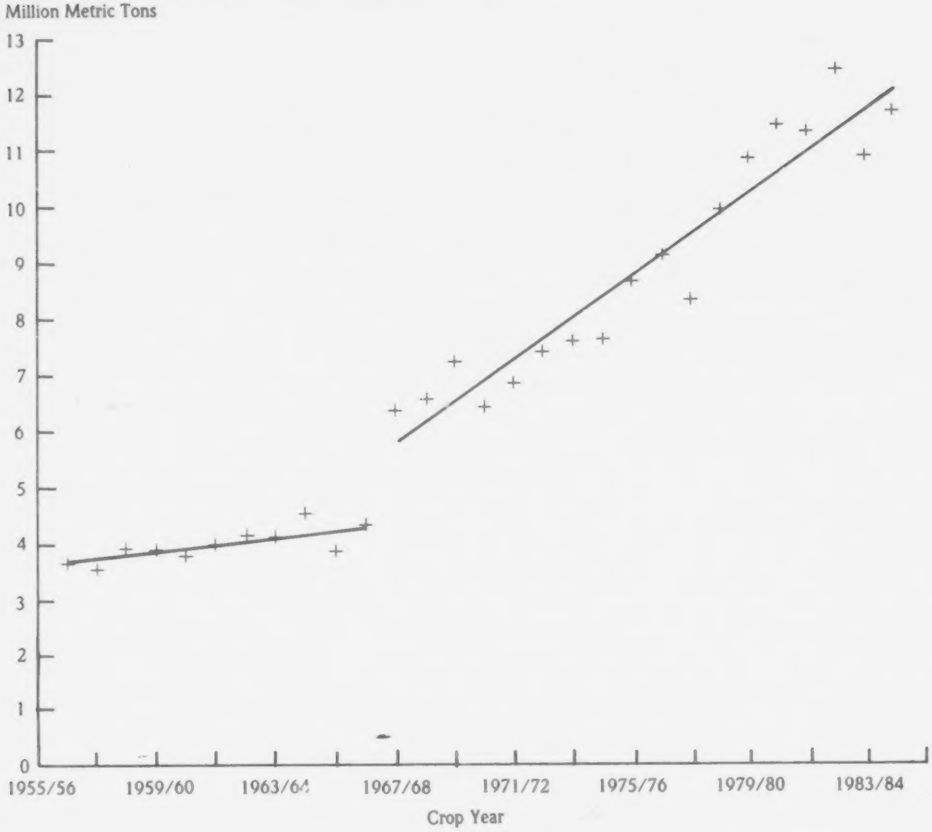
As shown in Figure 2, Pakistan's wheat production has increased rapidly, with a particularly large jump in the 1967/68 crop year. Because of the dramatic discontinuity in trend in that year, all estimates are made beginning in 1967/68. Both linear and exponential trends are reported in Table 5. Appendix 2 describes the method used to compare the fit of the linear and exponential equations.

With the exception of the small negative trend in area planted in the *barani* Punjab, all trends of both area and yield are positive. In all cases area trends are exponential and in most cases yield trends are linear. Yield trends in both the *barani* Punjab and other Baluchistan zone have been experiencing exponential growth.

The cotton/wheat zones in the Punjab and the Sind have the highest growth rates in area among the zones. This is as much due to an increase in double cropping as to increases in area. Normally, an increase in cropping intensity would be expected to be associated with a decline in yields. This holds true in the cotton/wheat Punjab, since historical yield increases are the second lowest of all the zones, but the cotton/wheat Sind has the highest linear trend in yields.

Projecting the national trends to the year 2000 leads to production of 19.9 million tons; the trends by zone lead to the higher figure of 20.9 million tons because of the exponential yields in two zones. These projections are based only on history, however, with no consideration of future constraints on production. There is a variety of reasons for believing that future growth in total area planted will not increase at the historical

Figure 2—Wheat production in Pakistan, 1956-85



Source: Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).

rate (Hamid et al. 1987). Even fairly optimistic assumptions show water availability between 1985 and 2000 increasing at less than half of the rate at which it expanded between 1968 and 1985. Since water availability is the primary constraint on cropped area, an overall growth of cropped area at 0.8 percent per year—only about half of the historical rate—is reasonable. Historically, wheat area as a percentage of total cropped area has been close to constant. Thus, future growth in wheat area is expected to grow at about 0.8 percent per year.

The primary impetus behind the historical increase in wheat yields has been the switch from traditional to high-yielding varieties (HYVs). This change is virtually complete, with the major wheat-producing areas now planting more than 95 percent of their land in HYVs. Thus, future yield growth depends on increases in the yields of HYVs. The national trend in yields of HYVs from 1968 to 1985 is only 0.9 percent annually, much less than the 2.7 percent overall trend reported in Table 5. Nevertheless, wheat yields are expected to grow at the historic *linear* trend. The linear trend may

Table 5—Linear and exponential trend growth rates for wheat area and yield, by zone

	Area		Yield	
Zone[a]	Linear Trend	Exponential Trend	Linear Trend	Exponential Trend
	(1,000 hectares)	(percent)	(kilograms/hectare)	(percent)
Rice/wheat Punjab	11.7	1.0[b]	40[b]	3.2
	(1.6)	(0.1)	(6.0)	(0.4)
Mixed Punjab	8.7	0.8[b]	25[b]	1.5
	(1.7)	(0.2)	(5.0)	(0.3)
Cotton/wheat Punjab	30.5	2.3[b]	23[b]	1.4
	(3.4)	(0.3)	(4.0)	(0.2)
Low-intensity Punjab	12.4	1.6[b]	21[b]	1.8
	(1.6)	(0.2)	(5.0)	(0.4)
Barani Punjab	−0.9	−0.2[b]	37	5.7[b]
	(0.8)	(0.1)	(6.0)	(0.8)
Rice/other Sind	2.8	0.9[b]	50[b]	4.2
	(1.6)	(0.6)	(4.0)	(0.4)
Cotton/wheat Sind	15.1	2.2[b]	66[b]	4.0
	(2.1)	(0.3)	(4.0)	(0.3)
Other NWFP	11.7	1.9[b]	37[b]	4.3
	(1.3)	(0.2)	(3.0)	(0.4)
Other Baluchistan	1.4	0.9[b]	49	6.5[b]
	(1.2)	(0.9)	(7.0)	(1.2)
All Pakistan	93.4	1.4[b]	36[b]	2.7
	(12.1)	(0.2)	(3.0)	(0.2)

Source: Author's estimates based on data from Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).
Note: The figures in parentheses are the standard errors.

[a] Punjab, Sind, North-West Frontier Province (NWFP), and Baluchistan are the four provinces of Pakistan.

[b] This trend is the best fit.

have been the best fit because the constraints in recent years are beginning to become apparent statistically. The linear yield trend, together with the area assumption, leads to an estimate of wheat production in the year 2000 of 17.8 million tons.

Changes in Wheat Consumption

Historical data on wheat consumption are not as readily available as data on production. The most detailed data are those contained in the Household Income and Expenditure Surveys (HIESs). In addition, annual estimates of consumption per capita can be derived through the food balance approach; that is, taking annual production of wheat, subtracting losses and government procurement, adding government offtakes, and dividing by the population. Both HIES data and food balance estimates are presented in Table 6.

Both the survey data and the food balance estimates move up and down from year to year, with no clear trend, particularly if the suspiciously low 1971/72 food balance figure is ignored. As is usual in such comparisons, the surveys estimate average per capita consumption 8-27 percent higher than food balance sheet data.

Table 6—Estimates of annual per capita wheat consumption, 1970/71-1986/87

Year	Rural	Urban	Average	Food Balance	Percent Difference
		(kilograms/year)			
1970/71	...	...	...	110	...
1971/72	139	119	134	98	–27
1972/73	...	...	...	115	...
1973/74	...	...	...	112	...
1974/75	...	...	...	113	...
1975/76	...	...	...	112	...
1976/77	...	...	...	112	...
1977/78	...	...	...	122	...
1978/79	147	115	138	120	–13
1979/80	...	...	...	115	...
1980/81	...	...	...	115	...
1981/82	150	100	136	111	–18
1982/83	...	...	...	115	...
1983/84	...	...	...	116	...
1984/85	139	105	129	119	–8
1985/86	...	...	...	118	...
1986/87	...	...	...	111	...

Sources: Data for 1971/72, 1978/79, and 1984/85 are from Pakistan, Federal Bureau of Statistics, *Household Income and Expenditure Survey* (Islamabad: Government Press, 1971/72, 1979, and 1984/85); data for 1981/82 are from Peter A. Cornelisse and Syed N. H. Naqvi, *The Anatomy of the Wheat Market in Pakistan* (Rotterdam: Erasmus University, and Islamabad: Pakistan Institute for Development Economics, 1984).

In some countries, the shift of the population from rural to urban areas could be expected to induce a shift in consumption patterns. In such a case, projections of demand should include an urbanization variable. Since Table 6 shows that urban wheat consumption is considerably lower than rural wheat consumption, such a consideration may appear to be important for Pakistan. Most analysts in Pakistan, however, attribute the difference in urban and rural consumption patterns to ethnic differences. At the time of partition, a large number of rice-eating Moslems migrated to Pakistan's cities from present-day India. Ever since, average wheat consumption has been lower and average rice consumption higher in the cities, but a wheat-eating Pakistani who migrates from the rural to the urban areas is not expected to shift from wheat to rice. Thus, urbanization does not enter the equation for the projection of consumption.

For purposes of projecting per capita consumption into the future, it is useful to estimate income elasticities and expected increases in income separately. Cross-sectional estimates of income elasticities for wheat from the 1979 HIESs yield 0.11 and 0.21 (derived from Cheema and Malik 1985 and Ahmed, Leung, and Stern 1986). Although time series estimates of income elasticities can differ significantly from cross-sectional estimates, in this case the time series estimate based on 1968-84 data yields an elasticity of 0.19. Thus the income elasticity of wheat appears to be small but positive.

A constant-price demand projection for wheat can be produced by combining the income elasticity with projections of population and income per capita. The historical annual growth in real GDP over the last 25 years has averaged 5.6 percent. This is assumed for future growth, with income per capita calculated by subtracting the population growth rate. In order to project population, an assumption needs to be made about the Afghan refugees. About 1.8 million refugees are assumed to stay in Pakistan. The population growth rate is projected to be constant at 3.1 percent annually until

1990, then to decline steadily to 2.6 percent by the year 2000. Together these assumptions imply that Pakistan's population will grow to 149 million by 2000. These numbers, combined with the income elasticity of 0.19, yield a constant-price demand for wheat of 19.1 million tons in 2000.

Balancing Supply and Demand

After allowing for a 10 percent reduction in the projected supply for seed, feed, and waste, 16.0 million tons are available for domestic consumption versus a demand of 19.1 million tons. This gap could be closed through trade or price increases. A rough estimate of the implied price change can be calculated by solving constant elasticity demand and supply curves using the long-term supply elasticity of 0.46 (the sum of the area and yield elasticities in the bottom row of Table 4) and a representative demand elasticity for a staple food of −0.25.

These numbers imply that a price rise of about 28 percent would balance supply and demand in the year 2000 at about 18 million tons consumed, or 20 million tons produced before the seed, feed, and waste reduction. This implies an average annual growth in wheat production of about 3.3 percent. The procurement price would rise to about 102 1985 rupees (Rs) per 40 kilograms from its 1985 level of Rs80, and there would be a corresponding rise in the release price.[15] This would still be below the import parity price unless world wheat prices were to fall precipitously. Per capita consumption actually rises slightly from its 1985 base under these assumptions to about 121 kilograms per year. The price rise thus serves primarily to cancel out the increase in consumption that would have resulted, all else remaining the same, from the increase in per capita income.[16]

Hamid et al. (1987) examine the effects of trends on 11 different crops, and use theoretically consistent matrices of supply and demand elasticities and different assumptions about trade policy to balance supply and demand by allowing prices to change, taking into account both own- and cross-price effects. The base case makes the same assumptions about trends as the single-market model in the previous paragraph. The interactions among commodities, however, result in wheat prices rising to Rs106 per 40 kilograms in 1985 rupees by the year 2000. Since this price is below import parity, production and per capita consumption of wheat adjust to the price rise and balance without exports or imports taking place. Production and consumption end up rising at 3.3 percent per year from 1985. Hamid et al. consider several other scenarios about world prices and trade policies, but wheat production and consumption in 1999/2000 do not vary from the base case by more than 2.0 percent.

Thus, in the remainder of this study it is assumed that wheat production and consumption will grow at about 3.3 percent per year in the medium term. In addition, Pakistan is expected to remain self-sufficient in a normal production year at prices between import and export parity. It is this situation that raises the possibility of holding interannual supply stabilization stocks. In order to conduct that analysis, it is necessary first to examine the historical pattern of instability in supply.

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[15] At the 1985 average exchange rate of about Rs16 per U.S. dollar, Rs80 per 40 kilograms is US$125 per ton.

[16] Alderman (1988a) has estimated a demand system that leads to a surprisingly high own-price demand elasticity for wheat of −0.96 in the rural areas and −0.34 in the urban areas. These higher numbers would lessen the price increase required to balance supply and demand, but would lower per capita consumption below its 1985 level.

Instability of Pakistan's Wheat Production

Instability is often measured in terms of the coefficient of variation of production—that is, the standard deviation of production divided by the mean, expressed as a percentage. A high coefficient of variation implies high instability relative to the average size of the crop, leading to increased fiscal costs for the same degree of price stability. The absolute level of instability is given by the standard deviation.

One simple method for measuring both the level of instability and its trend is to compute the coefficient of variation for detrended production data for successive 10-year periods. This is done for wheat at the national level in Table 7. The table is created in the following manner. A linear trend is calculated for area, yield, and production for each of the commodities for the entire time period. The standard deviation of the residuals from these regressions is then computed for each successive 10-year interval and divided by average production for that period to yield the coefficient of variation of the detrended series.

Table 7 shows that wheat production instability has been increasing over time, as the increase in yield instability has more than offset the decline in area instability. The coefficient of variation of production has increased from 4.8 to 7.8 percent from 1968-77 to 1978-87 even though the coefficient of variation for area has decreased from 4.6 to 2.1 percent. Yield instability more than doubles, from 3.3 to 6.7 percent, although much of the increase occurred in the first year.

Increases in total variability result from a combination of statistical factors. Hazell (1982, 1984) has developed a technique for decomposing the variance of crop production into component parts. Hazell (1984) explains the methodology in detail. This technique has been especially useful for identifying whether or not production variance has been changing over time and, if so, discovering the source of the change. In most of the countries studied to date, the variance of cereal production has been increasing.

Hazell (1988) presents basic results for numerous countries, including Pakistan. These results are informative because of the comparison across countries that they allow. Interestingly, the coefficient of variation of production of cereals in Pakistan for

Table 7—Changes in the means and variability of wheat production in Pakistan, 1968-87

Year	Mean			Coefficient of Variation		
	Production	Area	Yield	Production	Area	Yield
	(1,000 metric tons)	(1,000 hectares)	(metric tons/ hectare)		(percent)	
1968-77	7,420	6,054	1.23	4.8	4.6	3.3
1969-78	7,616	6,092	1.25	5.5	4.3	4.1
1970-79	7,949	6,145	1.29	5.4	3.5	4.1
1971-80	8,305	6,214	1.33	5.7	2.8	4.2
1972-81	8,805	6,315	1.39	6.4	2.9	4.2
1973-82	9,257	6,457	1.43	6.0	3.3	4.0
1974-83	9,754	6,600	1.47	6.4	3.7	4.0
1975-84	10,080	6,723	1.49	7.0	3.7	5.4
1976-85	10,483	6,868	1.52	6.8	2.8	5.5
1977-86	11,013	6,997	1.57	6.9	2.2	6.1
1978-87	11,310	7,114	1.59	7.8	2.1	6.7

Source: Author's calculations based on data from Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).

1972-83 is the second smallest of the 34 countries in the study. Although Table 7 shows some increase in instability since 1983, it is important to note that Pakistan's problems in this regard are far fewer than those for almost any other country in the world, primarily because of the prevalence of irrigation.

The results of Hazell's study are expanded here for Pakistan by extending the time period to 1984/85, considering only the post-green revolution period, and by using agro-ecological zone data. Two decompositions are carried out here. First, the variance of wheat production for the entire period is decomposed by production zone. Second, the change in the variance from the first half to the second half of the post-green revolution period is decomposed by production zone.

Table 8 presents the results of decomposing the total variance of wheat production by agroclimatic zone. The results are dominated by the correlations of wheat production among zones, as more than 76 percent of the variance can be attributed to these correlations. Nevertheless, it is interesting that of the remaining 24 percent of the variance, the rice/wheat Punjab zone accounts for a disproportionately high share. This zone produces about 16 percent of the country's wheat, but is responsible for over 25 percent of the variance attributable to individual zones. Cotton/wheat Sind, on the other hand, contributes less to total variance than its proportion of production.

A priori, one might expect the rainfed *(barani)* areas to be responsible for a large share of the variance, but this view is not supported by the analysis. The *barani* Punjab zone is responsible for only 5.5 percent of the zone-specific variance—higher than its share of wheat production, but small in total. Even if all the variance of other Baluchistan and other NWFP is added to the *barani* Punjab variance, the total is less than 10.0 percent. The figure of 10.0 percent overstates the rainfed areas' contribution to total variance, since both NWFP and Baluchistan grow some irrigated wheat.

In order to examine two contrasting zones, changes in the mean and variability of wheat production in the rice/wheat Punjab and the cotton/wheat Sind zones are

Table 8—A decomposition of the total variance of wheat production, 1967/68-1984/85

Zone[a]	Percent of Variance	Percent of Variance Directly Attributable to Zones	Percent of Production
Rice/wheat Punjab	6.0	25.6	16.5
Mixed Punjab	3.9	16.5	20.2
Cotton/wheat Punjab	6.7	28.5	24.3
Low-intensity Punjab	1.5	6.4	10.2
Barani Punjab	1.3	5.5	3.9
Rice/other Sind	0.5	2.3	4.3
Cotton/wheat Sind	2.4	10.1	13.0
Other NWFP	0.9	4.0	6.4
Other Baluchistan	0.3	1.1	1.2
Subtotal	23.5	. . .	. . .
Interzone covariances	76.5	. . .	. . .
Total	100.0	100.0	100.0

Source: Author's calculations based on data from Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).

Note: Parts may not add to totals because of rounding.

[a] Punjab, Sind, North-West Frontier Province (NWFP), and Baluchistan are the four provinces of Pakistan.

presented in Tables 9 and 10. Rice/wheat Punjab exhibits a large increase in production variability over time, all of which is attributable to an increase in yield variability. The cotton/wheat Sind zone, on the other hand, shows declining variability of both areas and yields. Overall variability is higher in cotton/wheat Sind at the beginning of the period, but by the end of the period yield variability in this zone is only 40 percent of yield variability in rice/wheat Punjab, more than offsetting the continued lower area variability in rice/wheat Punjab. A partial explanation for the rice/wheat Punjab increase in variability is that this zone was the hardest hit during the 1978 blight attack.

The variance decomposition approach can also be used to study changes in variability of wheat production more rigorously than the moving-average, coefficient-of-variation approach. For this purpose, the time period is divided into two segments of equal length: 1967/68-1975/76 and 1976/77-1984/85. The variance of the detrended series for each period is then computed.

Table 9—Changes in the mean and variability of wheat production, rice/wheat Punjab zone, 1968-85

	Mean			Coefficient of Variation		
Years	Production	Area	Yield	Production	Area	Yield
	(1,000 metric tons)	(1,000 hectares)	(metric tons/ hectare)	(percent)		
1968-77	1,233	1,073	1.15	6.4	3.0	6.4
1969-78	1,276	1,085	1.18	7.7	2.9	7.2
1970-79	1,345	1,088	1.23	7.9	2.0	7.4
1971-80	1,422	1,100	1.29	9.2	2.0	8.3
1972-81	1,513	1,109	1.36	9.8	1.8	8.7
1973-82	1,572	1,129	1.39	9.5	2.4	9.5
1974-83	1,653	1,146	1.44	9.3	2.8	9.0
1975-84	1,699	1,157	1.46	10.2	2.8	9.9
1976-85	1,751	1,171	1.49	10.3	2.5	10.2

Source: Author's calculations based on data from Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).

Table 10—Changes in the mean and variability of wheat production, cotton/wheat Sind zone, 1968-85

	Mean			Coefficient of Variation		
Years	Production	Area	Yield	Production	Area	Yield
	(1,000 metric tons)	(1,000 hectares)	(metric tons/ hectare)	(percent)		
1968-77	864	593	1.46	8.4	8.0	6.1
1969-78	912	601	1.52	8.5	7.4	6.2
1970-79	981	616	1.59	7.8	7.5	5.5
1971-80	1,040	628	1.65	6.8	6.6	5.2
1972-81	1,110	645	1.70	6.7	6.8	4.4
1973-82	1,195	668	1.77	7.4	6.9	4.2
1974-83	1,284	690	1.84	7.2	6.5	4.4
1975-84	1,352	708	1.89	7.4	6.3	4.3
1976-85	1,440	730	1.95	6.8	5.2	4.2

Source: Author's calculations based on data from Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).

Table 11 provides a breakdown of the change in the variance of wheat production by agroclimatic zone. Because of the high correlations between production fluctuations in the different zones, only 17 percent of the change in variance can be attributed directly to the different zones. However, rice/wheat Punjab is responsible for 40 percent of this change, even though that zone accounts for only 17 percent of the increase in total production. In contrast, the cotton/wheat Sind zone is responsible for only 3 percent of the change in variance but contributed 19 percent of the increase in production.

Thus, in Pakistan the variability of wheat production has been increasing over time, while the variability of most other cereals has been declining. This is in contrast to Hazell's (1988) finding that wheat production in most countries is becoming more stable over time. The increase in the coefficient of variation of wheat production, however, is not statistically significant.

In the analysis that follows, it is necessary to use a parameter for the inherent instability of wheat production, that is, the degree to which wheat production would fluctuate if government policy were constant. The historical degree of variability should be an overestimate of this number, since past changes in government pricing and marketing policies most likely have caused some of the observed production fluctuations. Estimates of yield variability should be closer to the purely random effect than production variability, although government policies could affect yields through their impact on the use of variable inputs such as fertilizer, and random weather events can affect harvested areas, particularly in *barani* zones, by causing a planted field to be abandoned.

Table 7 shows that the coefficients of variation of wheat yield and production are 6.7 percent and 7.8 percent, respectively, for the most recent 10-year period. Both of these figures are the highest for their series. Since the proper number to use for the inherent instability of production should be somewhat less than actual past yield instability, a figure of 6.0 percent is used here. Sensitivity analysis is included for a value of 7.0 percent. These assumptions should be on the high side, for as recently as 1974-83 the coefficient of variation was only 4.0 percent for yields. Consequently, the results below should be slightly biased toward high costs and high optimal stock levels. This bias should cover the relatively small degree of instability added by other cereals.

In sum, this section has shown that Pakistan's variability of cereal production is lower than that of most countries, although it has been increasing somewhat over time. Increases in variability in the Punjab—particularly in the rice/wheat Punjab zone—account for most of the increase in wheat variability. Chapter 4 examines how the government can use price, trade, and storage policy to stabilize consumption and prices in the face of these fluctuations in production.

Table 11—A decomposition of the change in variance of wheat production, 1967/68-1975/76 to 1976/77-1984/85

Zone[a]	Source of Change					Row Sum	Share of Variance Attributable Directly to Zones	Zonal Share of Increase in Production
	Change in Mean Yield	Change in Mean Area	Change in Yield Variance and Covariance	Change in Area Variance and Covariance	Area-Yield Covariance, Interaction Terms, and Residual			
					(percent)			
Rice/wheat Punjab	0.20	0.26	4.42	−0.02	1.87	6.73	39.76	16.8
Mixed Punjab	0.10	0.28	0.66	−0.18	0.64	1.49	8.83	10.7
Cotton/wheat Punjab	0.50	0.41	2.49	−0.72	2.18	4.86	28.73	23.2
Low-intensity Punjab	0.02	0.11	0.61	−0.05	1.01	1.70	10.05	8.0
Barani Punjab	0.06	0.00	1.26	0.00	0.24	1.56	9.21	5.6
Rice/other Sind	0.33	0.04	−0.06	−0.20	−0.20	−0.10	−0.58	5.8
Cotton/wheat Sind	0.86	0.32	0.09	−0.65	−0.05	0.57	3.40	19.0
Other NWFP	0.18	0.18	−0.25	0.01	−0.05	0.08	0.45	8.8
Other Baluchistan	0.03	0.02	−0.09	0.00	0.06	0.03	0.15	2.2
Total variance within zones	2.29	1.61	9.12	−1.81	5.71	16.91	100.00	. . .
Interzone covariances	7.36	2.51	33.40	−3.82	43.62	83.08	. . .	. . .
Column sums	9.65	4.13	42.52	−5.63	49.33	100.00	. . .	. . .

Source: Author's calculations based on data from Pakistan, Ministry of Food, Agriculture, and Cooperatives, Food and Agriculture Division, *Agricultural Statistics of Pakistan* (Islamabad: Government Press, 1985).

Note: Parts may not add to totals because of rounding.

[a] Punjab, Sind, North-West Frontier Province (NWFP), and Baluchistan are the four provinces of Pakistan.

4

THE DEMAND FOR INTERANNUAL SUPPLY STABILIZATION STOCKS

The most commonly heard justification for the creation of additional government storage space is the need to stabilize price and supply across surplus and deficit years. This chapter examines the rationale for holding interannual supply stabilization stocks in Pakistan. An optimization model is used to examine questions about the appropriate role of foreign trade and stockholding given the inherent instability of the production system and the government's objectives of stabilizing prices without committing an inordinate percentage of its fiscal resources. Another consideration is whether or not it is worthwhile for Pakistan to build additional storage to accommodate the interannual supply stabilization stocks that are efficient to hold. Policy modifications to make the system more efficient are investigated; for example, adjusting the domestic purchasing price to changes in the world price and to changes in domestic production. The value of such policy modifications is measured, and a scenario to show how these policies might work in practice is presented.

Efficient Policy Design for Price Stabilization

This section explores the elements of an efficient supply stabilization policy from the government's perspective. To present government officials with choices that are meaningful to them, it is necessary to take their objectives into consideration. Governments have multiple objectives in supply stabilization policy. Two of the most important will be considered here: minimizing price and consumption variability, and minimizing fiscal expenditure.[17] The price stability goal as defined here is concerned with the prevailing price paid for the staple food. Price rather than consumption is the stated goal, since price is observable but consumption is not. The government is assumed to stand ready to buy or sell sufficient quantities to enforce its price on both official and private markets, importing the quantities if necessary.

The assumed link between consumption stability and price stability implies that income and cross-price effects on wheat consumption are relatively minor. The predominance of wheat in calorie consumption ensures that cross-price effects from other markets on wheat consumption are small. The importance of income fluctuations on wheat demand can be estimated from past data. The coefficient of variation of detrended per capita income from 1971/72 to 1984/85 is 1.5 percent. Assuming an income elasticity for wheat of about 0.2, as discussed in Chapter 3, this implies that the coefficient of variation of wheat demand resulting from income fluctuations is only 0.3 percent. This is totally dwarfed by the 6.0-7.0 percent figure for the coefficient of variation of supply. Consequently, little information would be added to the results by distinguishing between consumption and price variability.[18]

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[17] In some countries, minimizing imports is a separate objective beyond minimizing cost. This is the case when the international market for the staple food is quite thin and thus supplies may not be available (rice, white maize) or when the closest commodity substitute for the domestic staple is considered inferior by the population (yellow maize for white maize). See Pinckney 1988b for a supply stabilization study with three government objectives.

Economists have debated whether or not price stability is welfare-enhancing (Waugh 1944; Oi 1961; Massell 1969; Samuelson 1972; Wright and Williams 1988). For the purposes at hand, that debate is irrelevant. With varying degrees of success, most governments have attempted to control prices for decades and will continue to do so. There is no question that governments—including the government of Pakistan—perceive it to be in the interest of the country and the government to stabilize prices. The question then becomes, What is the trade-off between price stability and fiscal cost, and how can a simple and efficient policy be designed to achieve the best possible combination of outcomes for those two objectives? Government justification of the price stability objective usually emphasizes the large short-run costs to poor consumers of high prices; these costs, rather than a consumer-surplus measure, are calculated below to give some indication of the costs of price variability.

The study is concerned with government control of the *variability* of prices rather than the *level* of prices. For this reason, the analysis in this chapter assumes that the government has a target price and considers how prices should vary from that target from year to year given government objectives and unanticipated changes in production and world price. Although in the model the target is assumed to be the price that clears the domestic market with no foreign trade when production is normal, results are not particularly sensitive to the choice of target within a reasonable range. Readers interested in an analysis of the appropriate level of prices can refer to other works, notably Dorosh and Valdés 1989. The remainder of this chapter shows clearly that the analysis of the appropriate amount of price variability is complex enough to stand on its own, without an analysis of price level.

Methodology

A simple, single-market model is used to characterize the wheat sector of Pakistan. As the advantages and disadvantages of this methodology have been discussed at length elsewhere (Pinckney 1988b), only a brief overview of the model is presented here. A fuller description is provided in Appendix 3.

This is an open-economy model, but the government is assumed to control all imports and exports. Thus, supply available to the population in this annual model is equal to the sum of opening private stocks, government sales or offtake, and stochastic production:

$$S_t = PS_t + O_t + Q_t, \tag{4}$$

where

S_t = supply,
PS_t = opening private stocks (held by all parties, including households),

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[18] A reviewer suggests that, since wheat production fluctuations are in the model, income fluctuations resulting from these supply fluctuations could be included. Again, the effect is so small that it can be ignored. Wheat production accounts for about 7.5 percent of value added in Pakistan's economy. Assuming that the coefficient of variation of value added equals that for production (it actually will be somewhat smaller, since prices will be inversely related to production), the coefficient of variation of per capita income that results from production fluctuations is 0.5 percent. The coefficient of variation of wheat demand thus would be 0.2 times 0.5, or 0.1 percent, a negligible amount.

O_t = offtake from government stocks, and
Q_t = production harvested during the time period.

Supply must be apportioned between carryout private stocks, PS_{t+1}, consumption, C_t, and government procurement, PC_t:

$$S_t = PS_{t+1} + C_t + PC_t. \tag{5}$$

Setting these equations equal and solving for consumption yields

$$C_t = (PS_t - PS_{t+1}) + (O_t - PC_t) + Q_t. \tag{6}$$

That is, consumption equals the net change in private stocks plus net offtake from government stocks plus production. For simplicity, it is assumed that

$$PS_t = PS_{t+1}. \tag{7}$$

Changes in private stocks at the end of the market year should be relatively small if the government succeeds in stabilizing interannual prices significantly. In Chapter 5 it is necessary to relax this assumption to study interseasonal prices.

With this assumption, equation (6) can be stated as

$$C_t = Q_t - NP_t. \tag{8}$$

That is, consumption equals production less net government procurement, NP. The net procurement variable is useful in an annual model. In any one year, the government both buys and sells grain for seasonal stabilization. The variable that buffers production fluctuations and thus affects the average annual price, however, is procurement net of offtakes. Thus, for the annual model, procurement and offtake can be collapsed into one variable. This is not possible in the seasonal model of Chapter 5.

Consumption is also a function of price, P_t:

$$C_t = f(P_t). \tag{9}$$

Supply balance on the government account implies that net procurement plus opening government stocks, GS_t, plus imports, M_t, must equal closing stocks plus exports, X_t:

$$NP_t + GS_t + M_t = GS_{t+1} + X_t. \tag{10}$$

Fiscal cost, FC, is a function of opening stocks, net procurement, imports, exports, the domestic price, and the world price, WP_t:

$$FC_t = g_1(GS_t, NP_t, M_t, X_t, P_t, WP_t). \tag{11}$$

Price variability, PV, is a function of the domestic price and the target price, P^*:

$$PV_t = g_2(P_t, P^*). \tag{12}$$

The government objective is to minimize present and expected future values of total government cost, GC, which is a function of fiscal cost and price variability. GC is consequently a broadly defined cost function, including both financial and political or welfare costs:

$$GC_t = g_3(FC_t, PV_t). \tag{13}$$

Thus there are three variables that, in any one year, are outside the control of the government: world price, WP_t, production, Q_t, and opening government stocks, GS_t. In the language of control theory, these are the three state variables that determine the state of the world. Given the state variables, the government chooses the values of three variables that it controls—net procurement, NP_t, imports, M_t, and exports, X_t—in order to minimize present and expected future values of total government cost, GC_t. Future values are discounted. The latter three variables are termed "control variables" in the control-theory literature.

Together, the state variables and the control variables determine the remaining variables. This system is optimized by stochastic dynamic programming. Inequality constraints on imports, exports, and government stocks make certainty equivalent methods, such as those used by Arzac and Wilkinson (1980), inappropriate.

The individual functions are as follows. Production, Q_t, is an exogenous, stochastic, normally distributed random variable. Thus, the costs of government policy are modeled for good, bad, and normal production years. For simplicity, neither supply nor demand is assumed to shift regularly over time. This assumption is useful if the expected growth rates of supply and demand are reasonably close to each other, leading to a normal-production-year equilibrium price that moves only slowly. Such is the case for Pakistan in the short run, as shown above. Because of this assumption, the cost figures are slightly understated, and the volumes mentioned for imports and stocks will grow over time. The assumption is necessary in order to allow the dynamic programming algorithm to stabilize over time. Adjustment of the stock volumes for expected future production growth is carried out below. The demand curve, equation (9), is assumed to have constant elasticity.

Food aid, which covers a set proportion of the shortfall in domestic supply in bad years, is received by the government and is one part of government imports. Sensitivity of the results to the presence or absence of food aid is tested below.

Fiscal costs are calculated as follows. The government's net procurement is multiplied by the price at which the grain is bought or sold. Thus, any costs incurred by the government in both buying and selling in the same market year are not included, since this is an interannual model. Net costs of foreign trade—both exports and imports—are calculated in a similar manner, adjusting for the difference between import and export parity. Foreign exchange is valued at a set premium for both imports and exports. Storage fees are a constant amount per ton of interannual storage. In addition, at the conclusion of the final year of each 10-year cycle in the simulation, a cost is incurred for rebuilding the stock to its opening level in year 1 of the simulation in order to facilitate comparison of different policies.

World price is modeled as a random walk, with movements independent of domestic production. It is particularly important that next year's expected price is close to this year's actual price; otherwise, the optimizing model will engage in speculative behavior.

Price variability, equation (12), is defined as the square root of the average squared deviation of actual price from the target price. This equals the standard deviation of price if the target price equals the ex post mean price. This is the simplest model that has two desirable characteristics: symmetry and increasing penalties for larger deviations. Symmetry is important, since the government is sensitive to the needs of both farmers and consumers. Increasing penalties are appropriate, since a very large change in price is considerably more undesirable than multiple smaller price changes. People starve and governments fall when prices rise dramatically, not when prices move marginally.

Government cost as defined in equation (13) is taken to be a weighted sum of fiscal cost and price variability, with the weight on price variability so that the monetary unit becomes the numeraire of the system. The weight is unknown, representing the relative preference of the government for saving money versus stabilizing prices. Different values of the weight are tested, each representing a different set of government priorities, with the results clarifying how the optimal policy adjusts to different political preferences. This allows for the measurement of the trade-off between the two government objectives.

During the optimization procedure, the algorithm finds the values of government procurement, offtake, and foreign trade that minimize the cost function for every modeled combination of domestic production, world price, and opening stocks. The dynamic programming procedure continues until the optimal policy for one year is the same as the optimal policy for the next year. Thus the outcome of the optimization procedure is a policy that does not vary from year to year. This policy is discrete, however, since the procedure only considers selected possible values for production, world price, and the other variables. Consequently, the discrete policy is interpolated linearly, so as to be continuous, and simulated over 300 10-year cycles of random production and world price. The values of the objectives are calculated in the simulation, and results are reported in the tables and the graphs.

For the values of specific parameters, see Appendix 1, Table 29.

Optimal Policies versus Price Band Policies

Most government price stabilization schemes have tried to stabilize prices within a band. That is, a maximum price and minimum price are set, with the government promising to enter the market with sufficient purchases or sales to keep the domestic price from moving outside those limits. Normally, no government intervention is assumed if the price stays between the maximum and minimum. On the foreign trade side, it is frequently proposed that imports should be triggered by a minimum stock size and exports triggered when some maximum stock size is reached.

To show how the optimal policies differ from these simple price band/buffer stock policies, one of the 300 10-year cycles of the simulation for both types of policies is presented in Table 12. Both policies target a price of Rs85 per 40 kilograms, and over all 300 cycles their average levels of price variability are equal. The price band/buffer stock policy has stock triggers for imports and exports at 0 and 200,000 tons, respectively. The optimal policy costs about Rs85 million less annually over all 300 cycles than this price band policy.

For this particular cycle, the optimal policy costs about Rs60 million less annually. Three years out of 10, however, the price band policy is substantially cheaper than the optimal policy. In each of the 3 years—years 2, 6, and 10—the optimal policy opens a bad production year with no stocks, while the price band policy has substantial stocks. These years cannot be looked at in isolation. The only reason that the price band policy is able to outperform the optimal policy in year 10, for example, is because it failed to earn money from exports in year 9. The problem is dynamic, and the policies can only be judged in a dynamic context. The distribution of prices is dramatically different in the two policies. In 7 out of 10 years, the price band policy is at either its

Table 12—Simulation of optimal and price band policies: one cycle

Year	World Price	Production	Net Procurement		Domestic Price		Net Imports (Including Aid)		Closing Stocks		Annual Cost		Present Value of Sum of Annual Costs	
			(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	(US$/ metric ton)	(1,000 metric tons)			(Rs/40 kilograms)		(1,000 metric tons)				(Rs million)			
0	...	...	...	...	...	...	...	...	100	100	...	...	...	...
1	102	12,869	−117	0	85	88	17	0	0	100	−205	43	−205	43
2	92	11,353	−1,360	−1,349	92	92	1,359	1,249	0	0	−773	−1,027	−927	−917
3	68	13,681	230	376	76	79	−117	−176	113	200	380	669	−595	−333
4	68	13,891	376	586	75	79	−285	−586	204	200	538	723	−156	258
5	84	13,308	−23	3	78	79	−180	−3	0	200	−257	87	−352	324
6	85	11,284	−1,450	−1,418	91	92	1,450	1,218	0	0	−904	−1,396	−997	−671
7	108	12,991	−3	0	85	85	3	0	0	0	2	0	−995	−671
8	135	13,136	144	0	85	82	−144	0	0	0	1	0	−995	−671
9	157	13,474	517	169	86	79	−517	0	0	169	−199	404	−1,110	−436
10	151	12,605	−69	−97	93	92	69	0	0	72	85	−192	−1,064	−541
Replace stock adjustment	...	...	...	...	...	...	...	...	...	...	187	52	−962	−512
Average annual cost	...	...	...	...	...	...	...	...	...	...	−128	−68	...	...

Source: Author's calculations.
Note: (1) = optimal policy; (2) = price band policy.

maximum or minimum price. The optimal policy, on the other hand, has 4 years when the price is within one rupee of the target price. In 3 years, the price resulting from the optimal policy is below the minimum price of the price band policy. In each case, supplies are abundant and the world price is low. Similarly, the one year when the optimal policy price is above the price band's maximum is when production is low and the world price is high.

Year 9 is perhaps the best example of why the optimal policy is more efficient than the price band policy. Production is fairly high—high enough so that the price band minimum is reached and that policy withdraws 169,000 tons from the market, placing all of it into storage. In contrast, the optimal policy has a net procurement of 517,000 tons, bringing the domestic price very close to the target price, and exports the entire amount at a profit, since the world price is US$157 per ton. The net result is earnings of Rs200 million for the optimal policy and losses of Rs400 million for the price band policy, with the price outcome also preferable under the optimal policy.

These examples suggest that *the optimal policy is superior because of greater responsiveness to the world price and domestic production.* This suggestion is explored in more detail below, after a consideration of average results for all of the cycles.

Optimization Results

Table 13 presents results of the optimization model for the base case, in which production instability is 6 percent and food aid is available. The first two columns of the table present the government objectives of price variability and fiscal cost. The third and fourth columns present two other items of concern to the government that

Table 13—Optimal policy results: base case

					Components of Cost			
Price Variability	**Average Annual Fiscal Cost**	**Standard Deviation of Cost**	**Average Imports, 10-Year Period**	**Average Closing Stock**	**Storage Costs**	**Domestic Costs of Foreign Trade**	**Net Other Domestic Costs**	**Direct Foreign Exchange Losses**
(Rs/40 kilograms)	(Rs million)		(million metric tons)	(1,000 metric tons)		(Rs million)		(US$ million)
14.7[a]	−164.5[ab]	138[a]	1.76[a]	0[a]	0.0[a]	193[a]	212.5[a]	−30.5[a]
5.9	−44.9	125	1.95	34	7.4	171	−14.5	−11.2
5.4	−26.5	128	2.03	30	6.6	179	−7.7	−10.9
4.8	−4.5	132	2.11	37	7.8	186	−4.3	−10.4
4.2	19.9	137	2.20	40	8.3	194	2.6	−9.9
3.7	43.6	140	2.27	43	8.8	201	12.1	−9.5
3.1	70.9	144	2.39	23	5.1	214	22.5	−9.1
2.6	94.0	148	2.48	24	5.1	220	25.2	−8.4
1.9	123.6	155	2.57	26	5.4	229	35.4	−7.8
1.4	150.1	163	2.66	26	5.5	236	44.4	−7.3
0.9	174.7	167	2.77	12	2.2	246	49.4	−6.6

Source: Author's calculations.

Notes: In the base case, food aid is included and production variability is 6 percent. The 1985 exchange rate was about Rs16.00 = US$1.00.

[a] Free-market result.

[b] This amount is not fiscal cost but net cost to the economy of domestic and foreign wheat marketing.

are not included in the objective function: the variability of fiscal cost and average total imports during 10 years.[19] The fifth column presents average closing stocks.

The last four columns of Table 13 present a breakdown of fiscal costs into four components. The first component, storage costs, consists of the direct cost of storing wheat, including the value of physical losses and the costs of putting the grain into and taking it out of the storage facility. The second component, the domestic costs of foreign trade, includes charges for transportation, bagging, and handling of wheat exports, and the excess costs of handling wheat imports beyond the costs of handling domestic wheat. The third component, net other domestic costs, is composed primarily of the difference between the value of domestic sales and the value of domestic purchases. The implicit value of the stock change between the first and tenth years is also included in this component. The last column gives the direct foreign exchange losses, expressed in U.S. dollars. A negative value indicates a gain in foreign exchange on average through wheat operations. This component includes the cost of foreign shipping on all imports (including food aid).

The first row of Table 13 presents results of a run that attempts to describe the free-market solution. As shown in Gustafson (1958, 48-49), maximization of a producer/consumer surplus function yields the free-market solution. This technique has been used here. There is no government intervention in either domestic or foreign trade, necessitating the change in objective function. This run can be considered a test of the stability of domestic prices under a free-trade regime.

The results indicate that the government has stabilized prices compared with what would have been the case in the absence of intervention. Price variability in the nonintervention case is almost Rs15 per 40 kilograms; this implies that, if the average harvest-time price were Rs80 per 40 kilograms, one year out of six the price would be greater than Rs95 and one year out of six the price would be less than Rs65. Column 2 for this row is not fiscal cost but net cost to the economy of domestic and foreign wheat marketing. A large profit is made, most of it in foreign exchange, as shown in the last column. On average, the nonintervention solution raises the average domestic price above its equilibrium level by buying more than it sells domestically and exporting the difference in years of high world prices.

The substantial change in average price possible in the nonintervention case calls into question the model's assumption about no supply response to price. Adding a supply response would cause profits made under this scenario to increase further, as more would be grown—and thus exported—in periods of high world prices. It would also increase average imports, as domestic production would decrease in low-world-price periods, which are the only times when imports take place in the nonintervention scenario. Price variability should be unaffected by such a change.[20]

The other 10 rows in Table 13 present optimal solutions under different possible relative preferences between price stability and low fiscal expenditure. There are several general observations to be made about the results.

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[19] Column 3 presents the standard deviation of the average price over 10 years, not the standard deviation of the annual cost. The latter figure can be approximated by multiplying the number in column 3 by the square root of 10 (about 3.2).

[20] For all optimization runs except the nonintervention case, ignoring supply response is reasonable because of the resulting simplicity of the model and the absence of significant changes in expected price from year to year (Pinckney 1988b).

First, *fiscal costs increase substantially as price variability is limited.* This is the trade-off between the two government objectives included in the model. On average for the range considered here, the trade-off is about Rs45 million annually for each one-rupee decrease in price variability. The trade-off increases slightly as price variability declines. Consequently, a policy that would efficiently keep harvest-time prices between Rs70.00 and Rs90.00 per 40 kilograms for 9 years out of 10 costs about Rs220 million more per year than a policy that keeps those prices between Rs78.50 and Rs81.50.[21]

Second, *government can stabilize prices significantly at no cost on average.* When price variability is about 4.6—that is, harvest-time prices are kept between Rs72.50 and Rs87.50 per 40 kilograms for 9 out of 10 years—average costs are zero. The government on average earns foreign exchange and spends domestic currency.

Third, *the variability of cost is quite high.* Over a 10-year period, the expected average annual cost of the policy with price variability of 0.9 is about Rs175 million, but since the standard deviation of this cost is Rs167 million, there is a one-in-six chance that the cost would average less than Rs8 million annually, and a one-in-six chance that the cost would average more than Rs332 million annually. In any single year, there is a one-in-six chance that the cost will be greater than Rs700 million, and a similar chance that the policy will make a profit of more than Rs350 million.[22] The variability of cost increases somewhat as price variability decreases. Thus, even though the government might aim at a policy with zero cost, over a long period of years the costs could be high.

Fourth, all of the efficient policies have net foreign exchange earnings on the wheat account, but *there is a negative relationship between price stability and foreign exchange earnings.* The extent to which this result is dependent on the assumptions about food aid is tested below.

Finally, *average closing stocks are exceptionally low,* ranging from 12,000 to 43,000 tons. As a consequence, storage costs are quite low relative to other costs. Recall that these stocks are only those for interannual supply stabilization; actual stock levels will be higher because of the other reasons for storage. Supply stabilization stocks are held in these policies only when the world price of wheat is less than US$80 per ton. In real terms, such a price would be a record low for wheat.

When the world price is US$60 per ton, the policies with higher price variability hold as much as 400,000 tons of stock before exporting the excess. No policies studied here hold more than 600,000 tons under any circumstances. The reasons for this relatively low level of interannual stockholding are explored in the following section.

Rationale for Interannual Stockholding

The policy-decision variables under the government's control can be considered as sequential. The government opens the marketing year with some opening stock, S_{t-1}. Given production, a certain amount is procured and sold, leaving a net level of procurement, PC_t.[23] The sum $S_{t-1} + PC_t$ is termed here "available supply." If available supply is negative, the government must import to meet domestic demand. If available supply is positive, the government can decide how much to export and how much to store.

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[21] In order to calculate these numbers, the price variability is multiplied by 1.645, since 90 percent of a normal distribution falls within this number of standard deviations of the mean.

[22] The annual cost figures are calculated by taking the standard deviation of the 10-year average cost, Rs167 million, and multiplying it by the square root of 10 to produce the standard deviation of annual cost.

[23] The decision variable is considered in volume terms here for consistency with the trade/stock decision variable. As there is a one-to-one correspondence between price and consumption, however, this decision variable determines price in conjunction with production.

This decision, then, involves comparing the known value of exporting the commodity this year with the expected value of holding the commodity for possible sale next year. The value of 1 ton of available supply this year is simply the present export parity price, XP_t. The expected value next year is a weighted average of the possible uses of the stock next year. These possibilities are as follows:

1. Export next year. The expected value today for exporting next year is $[E(XP_{t+1}) - STCH]/D$, where E(.) is the expectations operator, XP is export parity as above, STCH is the cost of storing the commodity for one year, and D is the discount rate applied because of the time value of money.[24] Assuming that the government has no inside information about world wheat prices, it is reasonable to assume that the expected price next year equals the present price; that is, $E(XP_{t+1}) = XP_t$. Thus, this component of the value of the stored commodity can be simplified to $(XP_t - STCH)/D$.

2. Sell domestically next year, displacing imports. In this case, the value of the commodity is import parity next year, as opposed to next year's domestic price. If imports are displaced, the only difference between storing or not storing this year is not having to import next year. Consequently, the value is $[E(MP_{t+1}) - STCH]/D$, which can be simplified as above to $(MP_t - STCH)/D$, with MP being import parity.

3. Store again next year. This can be calculated by setting up possibilities (1) and (2) for several years into the future until the discount rate minimizes the importance of additional years, and then working backward to calculate the value of storing an additional year. These are the only possible uses for the stock.[25] The value of storing, therefore, is the weighted average of these three components, with the probability of each occurring next year used as the weights.[26] The decision will depend on the value of the parameters and the probabilities.

The dynamic programming exercise can be considered a complex method for determining the probabilities of the different reasons for storage. As an example, however, assume that the probability of exporting the stock next year equals the probability of displacing imports next year at 0.45. Thus the probability of storing again next year equals 0.1. Given other parameters (see Appendix 1, Table 29) and a world price of US$110 per ton, the values are as follows:

Use of Stock	Present Value per Ton	Probability
Export next year	Rs1,130	0.45
Displace imports next year	Rs2,181	0.45
Store again next year	Rs1,101	0.10
Weighted average	Rs1,600	. . .
Export this year	Rs1,663	. . .

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[24] Analytically, based on standard economic theory, it is inappropriate to apply both a discount rate and an interest rate in an interannual model in real prices. See Gardner 1979.

[25] The fourth possibility, sell domestically next year, not displacing imports, is only possible if the government allows the domestic price to be affected by its opening stock level. Such behavior does occur in the optimal policies to a minor extent; it is left out to simplify the discussion.

[26] In the model formulated above, government storage has a negative effect on the amount of food aid received. The expected negative value of this amount should also be included in the calculation, but is excluded for clarity of exposition.

As the world price declines, the difference between the value of exporting and the value of storing decreases. For these probabilities, the two are equal when the world price is US$63 per ton. Thus, if these probabilities were correct, no wheat would be stored with world prices above US$63.

Each additional ton stored, however, has a different set of probabilities for its disposal in the next year. As more is kept in store, the probability of each additional ton displacing imports next year declines, since a higher percentage of production shortfalls will be met with already existing stocks. Similarly, the probabilities of exporting next year and storing again increase. This decreases the incentive to hold additional stock. Small changes in probabilities have a large impact on the world price at which additional grain will be put in store. For example, suppose that the probabilities for the three outcomes above change from 0.45, 0.45, 0.10 for the first ton stored to 0.46, 0.43, 0.11 for the 100th ton stored. In this case, the world price at which storage takes place declines from US$63 to US$48, even though the probability change is small.

Note that the decision of whether or not to store the wheat makes no reference to the price paid domestically to purchase the crop. Unfortunately, for accounting reasons grain marketing authorities in some countries have been restricted from exporting because of the accounting loss they would incur if their stock of grain were exported at a price beneath their purchase price. Valuing the stock at its purchase price is an accounting fiction, however. Economically, the value of the stock is its most profitable possible use, and this value has been determined in the calculation above. Thus, it saves money at times to export rather than store, even though an accountant may have to enter a loss in the marketing board's books.

Sensitivity of Optimal Stock Size to Assumptions

Assumptions about food aid and the variability of production will affect the average stock size that results from the optimal policies. This section tests to see what effect ignoring food aid and assuming a higher variability of production have on storage and other outcomes.

As shown in the first section of this chapter, assuming a coefficient of variation for production of 6 percent is reasonable. There is some indication, however, that variability has been increasing over time. For future planning, testing the sensitivity of storage size to production variability of 7 percent is desirable.

In terms of the analysis in the previous section, a rise in production variability will increase both the probability of exporting the stock next year and the probability of using the stock to displace imports. Although these two effects are offsetting to some extent, an equal increase in both probabilities raises the world price at which storage is profitable. For example, in the table on p. 43, if these two probabilities are both raised from 0.45 to 0.48, the world price at which storage becomes profitable increases from US$63 to US$87.

Table 14 presents optimization results with all parameters the same as in Table 13, but with production variability increased to 7 percent. Figure 3 shows these results graphically, along with the results for no food aid.

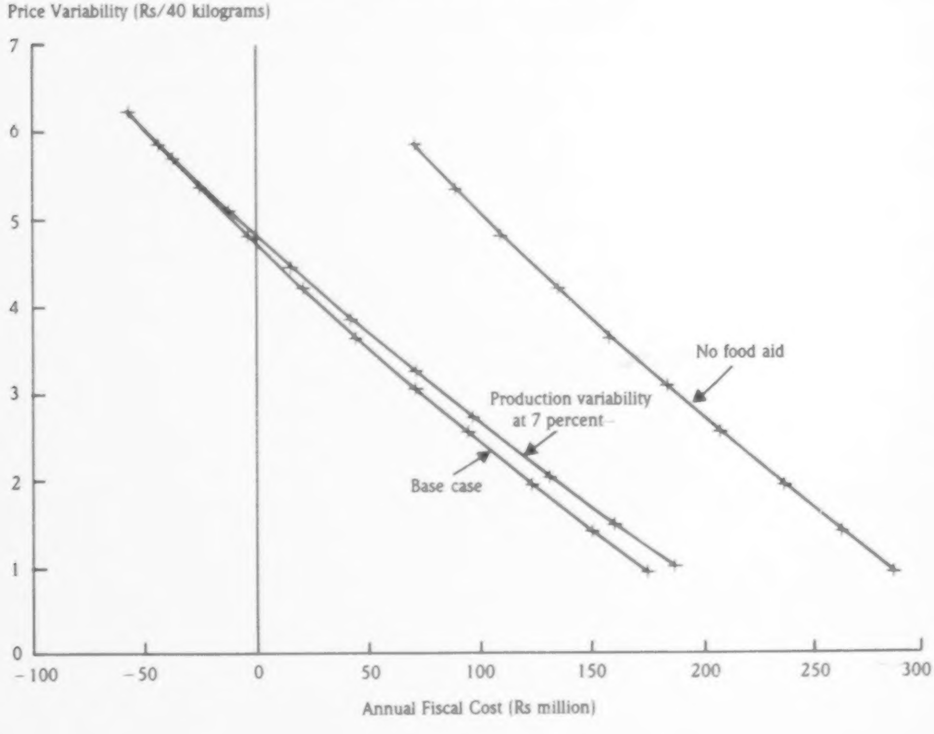
The production variability change increases stockholding only slightly. Costs are almost identical at the higher range of price variability, although cost differences increase to about Rs15 million annually at lower levels of price variability (this is clearer in Figure 3 than in Table 14 because of differences in price variability). These cost differences are small, partly because the higher production variability induces increased food aid. The higher variability raises average imports and exports by almost 20 percent,

Table 14—Optimal policy results: production instability at 7 percent

					Components of Cost			
Price Variability	Average Annual Fiscal Cost	Standard Deviation of Cost	Average Imports, 10-Year Period	Average Closing Stock	Storage Costs	Domestic Costs of Foreign Trade	Net Other Domestic Costs	Direct Foreign Exchange Losses
(Rs/40 kilograms)	(Rs million)		(million metric tons)	(1,000 metric tons)	(Rs million)			(US$ million)
6.2	−59.0	150	2.36	40	8.7	205	−30.7	−12.9
5.7	−38.2	154	2.44	35	7.5	214	−21.5	−12.7
5.1	−13.3	158	2.53	41	8.6	221	−15.1	−12.2
4.5	14.5	164	2.63	43	9.1	228	−5.2	−11.6
3.8	42.0	169	2.72	46	9.5	239	5.3	−11.3
3.3	71.3	173	2.85	24	5.2	253	19.0	−11.0
2.7	96.9	177	2.95	25	5.3	260	22.5	−10.2
2.0	130.5	185	3.05	27	5.5	269	35.9	−9.6
1.5	159.7	194	3.14	27	5.6	277	46.9	−9.1
1.0	186.2	197	3.26	13	2.3	288	53.5	−8.4

Source: Author's calculations.

Figure 3—Optimal policy trade-off curves: three variations of parameters



but this additional foreign trade is conducted with only small losses. Thus, changing the assumption about production variability has little effect on storage or expected fiscal costs.

Assuming no food aid, on the other hand, increases costs substantially and increases average stockholding to about 80,000 tons. In the base case, food aid amounts to about 560,000 tons over a 10-year period, thus constituting about one-fourth of total imports. The removal of this grant adds about Rs110 million to the average annual cost, as displayed in Figure 3. Table 15 shows that the foreign exchange account suffers most in comparison to the base case, as would be expected.

Table 15 shows only average stockholding. For an analysis of storage capacity, maximum stockholding is an important variable. The largest amount stored increases 200,000 tons over the base case, rising to 600,000 tons when the world price is US$60 per ton; as much as 50,000 tons are held when the world price is US$100 per ton. Nevertheless, when the world price is US$110 per ton or higher, no interannual supply stabilization stocks are held, regardless of whether or not food aid is available.

The assumption of no food aid is extreme. For the foreseeable future, Pakistan will be able to arrange for significant amounts of food aid from the international community in poor crop years. The absence of large supply stabilization stocks even in this extreme case strongly indicates that the requirement for this component of stockholding is quite small.

Computing the Value of Additional Storage Space

Despite low average stockholdings, all three sets of optimization results occasionally hold stocks of 400,000-600,000 tons. In the model, neither construction nor depreciation costs are included, since storage space of that amount is assumed to be available already. But in planning for future storage capacity, the question arises, Should Pakistan build 400,000-600,000 tons of storage capacity for supply stabilization besides storage requirements for other uses?

In order to assess the cost advantages of having the additional storage, the optimization model is run with maximum storage capacity constrained. Then the average cost

Table 15—Optimal policy results: no food aid

					Components of Cost			
Price Variability	Average Annual Fiscal Cost	Standard Deviation of Cost	Average Imports, 10-Year Period	Average Closing Stock	Storage Costs	Domestic Costs of Foreign Trade	Net Other Domestic Costs	Direct Foreign Exchange Losses
(Rs/40 kilograms)	(Rs million)		(million metric tons)	(1,000 metric tons)	(Rs million)			(US$ million)
5.9	69.7	118	1.87	57	17.5	161	−23.8	−4.6
5.4	88.9	123	1.94	62	17.9	169	−15.5	−4.4
4.8	109.3	130	2.01	69	19.4	174	−14.3	−3.7
4.2	135.2	137	2.09	76	21.2	182	−4.5	−3.4
3.7	157.9	144	2.16	81	22.2	188	2.7	−3.0
3.1	183.0	151	2.25	84	23.2	196	7.8	−2.3
2.6	207.8	158	2.35	82	21.4	205	14.9	−1.8
1.9	237.3	167	2.44	80	21.4	214	25.9	−1.3
1.4	263.2	178	2.51	85	23.5	220	33.4	−0.7
1.0	287.4	184	2.61	80	22.7	227	37.2	0.0

Source: Author's calculations.

of the constrained policy can be compared with the average cost of the unconstrained policy, keeping price variability the same in the two cases. The value of the additional capacity is assessed by comparing the change in fiscal cost.

When this is done, the value of the extra storage space turns out to be small, primarily because of the low percentage of years in which it is used. The average gross benefit ranges from Rs100,000-500,000 annually for each additional 100,000 tons of storage, with the actual number sensitive to the chosen degree of price variability and how much storage has already been built. The Experience, Zor, and Ferguson (1986) study estimates that construction costs are about Rs70 million per 100,000 tons capacity, and maintenance costs are between Rs250,000 and Rs1 million annually. Thus the value to the country of building extra capacity for supply stabilization is barely equal to the maintenance costs of the facility; the benefits do not begin to pay the country back for the capital costs of construction.

Therefore, in terms of planning for future storage requirements, no additional capacity should be built for interannual supply stabilization. If capacity is available, in years of abundant supply and very low world prices it will make sense to store up to a few hundred thousand tons, but the value of always having that capacity available is only equal to average maintenance costs.

Lessons for an Efficient Supply Stabilization Strategy

Characterizing the Efficient Policies

A policy produced by the optimization process meets the government objectives of price stability and low fiscal cost better than any alternative policy, given a set of government preferences. These policies, however, are difficult to understand and describe. Simpler policies are required if the optimization exercise is to have an effect on the policymaking process. A detailed examination of what makes the optimal policies efficient can provide clues for the design of simpler, yet efficient, policies.

Recall that government intervention can be considered as two separate steps: first, making a decision about net procurement, and second, allocating available supply between exports and carryover stocks. The efficient rule for supply allocation is already clear. When aid is included in the model, the optimal policies do not hold any stock when world prices are US$80 per ton or above. Thus the decision on how to allocate available supply between stocks and exports is simple for most world prices: hold no stocks.

The earlier decision—determining net procurement and the domestic price—is more difficult to characterize. The simulation of one 10-year cycle in Table 12 suggests that a key difference between an optimal policy and a price band policy is the degree to which the domestic price responds to the world price and to domestic production. For example, the price band policy reaches its minimum price in years 3, 4, 5, and 9, when domestic production is high. The optimal policy also produces low prices in the first three cases, when world prices are low, but offers farmers a much higher price in year 9, when profitable exports are possible.

In order to examine this relationship further, optimal net procurement is plotted against production for one of the optimal policies, holding world price within a fairly narrow range (Figure 4).[27] The figure suggests that the relationship between these two

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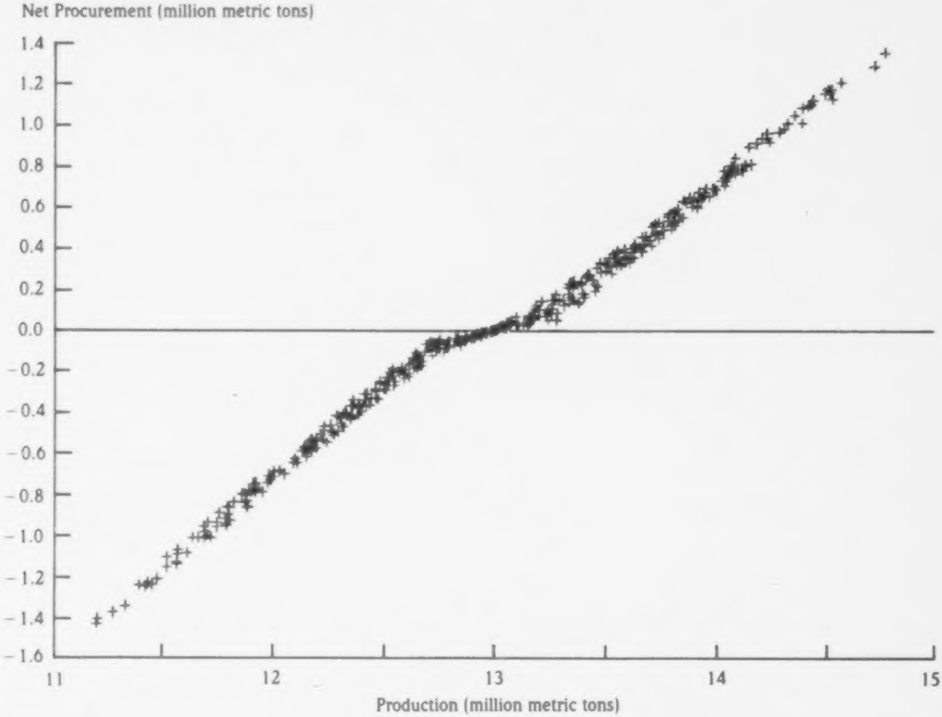
[27] Since only nine possible production levels are modeled in the optimization process, these points are all taken from the simulation of the interpolated optimal policy.

Figure 4—Net procurement function



Note: Price variability is 5.9. The figure includes all observations in the simulation in which the world price is between US$100 and US$120.

variables is close to linear, but that a kinked linear relationship with a flatter section close to mean production may model the optimal relationship more closely. This hypothesis is investigated using regression analysis in Table 16. The regression results should clarify the key elements in the superiority of the optimal policies over the price band policies.

In this table, five regression equations are reported for each of three levels of price variability. The dependent variable in each case is net procurement in years of the simulation of the interpolated optimal policy. As there are 300 10-year cycles, there are 3,000 possible observations. In order for the regression results to reflect accurately the optimal policy, however, it is necessary to exclude observations that may bias results. First, years with values for world price or production that are far from those modeled in the optimization process are excluded. Since the optimization process considers only world prices between US$60 and US$180 and production between 11.2 and 14.8 million tons, only observations in which the world price is between US$50 and US$190 and production is between 11.1 and 14.9 million tons are included. These restrictions lower the total number of observations to 2,587.

The second restriction on observations has to do with opening stocks. In this case, there is no problem with the range of the stock variable but with the distribution of

Table 16—Net procurement function

Level of Production	Constant	World Price	Production (Qt)	R^2	Standard Error of Regression	N
(1,000 metric tons)						
		Regression Results for Price Variability at 0.9				
(1) All production levels	−46.42	0.60 (0.44)	. . .	0.001	708.7	2,287
(2) All production levels	−12,496	0.62 (0.01)	0.956 (0.0003)	1.000	12.3	2,287
(3) (a) $Qt > 13{,}300$	−12,813	0.69 (0.01)	0.978 (0.001)	0.999	9.3	821
(b) $12{,}700 < Qt < 13{,}300$	−11,969	0.50 (0.01)	0.917 (0.002)	0.996	10.2	692
(c) $Qt < 12{,}700$	−12,729	0.66 (0.01)	0.976 (0.001)	0.999	8.5	774
		Regression Results for Price Variability at 3.1				
(1) All production levels	−205.3	2.06 (0.40)	. . .	0.012	632.0	2,287
(2) All production levels	−11,300	2.07 (0.02)	0.852 (0.001)	0.997	34.2	2,287
(3) (a) $Qt > 13{,}300$	−12,368	2.59 (0.01)	0.925 (0.001)	0.999	12.5	821
(b) $12{,}700 < Qt < 13{,}300$	−9,350	1.54 (0.02)	0.707 (0.004)	0.979	19.1	692
(c) $Qt < 12{,}700$	−12,274	2.06 (0.01)	0.933 (0.001)	0.999	9.0	774
		Regression Results for Price Variability at 5.9				
(1) All production levels	−415.5	3.91 (0.33)	. . .	0.057	531.5	2,287
(2) All production levels	−9,686	3.92 (0.04)	0.712 (0.002)	0.986	64.2	2,287
(3) (a) $Qt > 13{,}300$	−11,433	5.13 (0.02)	0.827 (0.002)	0.995	23.2	821
(b) $12{,}700 < Qt < 13{,}300$	−6,419	2.78 (0.04)	0.471 (0.008)	0.914	37.2	692
(c) $Qt < 12{,}700$	−11,529	3.73 (0.02)	0.866 (0.002)	0.997	19.3	774

Source: Author's calculations.

Notes: The figures in parentheses are the standard errors of the estimated coefficients. Regressions are for (1) world price alone on entire sample, (2) world price and production on entire sample, and (3) world price and production on three subsets of the sample.

the size of stocks in the observations. Opening stocks in year 1 of each cycle are 100,000 tons, while average closing stocks are much lower. Thus, one-tenth of the observations have stocks of 100. In order to avoid a bias due to a large number of relatively high stock years, only the last nine years of each simulation are included in the regression, lowering the total number of observations to 2,287.

Regressions are reported for world price alone on the entire sample, for world price and production on the entire sample, and for world price and production on three subsets of the sample: production less than 12.7 million tons, greater than 13.3 million tons, and between those two values. This final partitioning is consistent with the pattern seen in Figure 4.[28]

The regressions help to explain how the optimal policies act and how such policies change as the government preference for price stability changes. Net procurement is more responsive to the world price and less responsive to production when price variability is high. Estimating three regressions—one each for low, medium, and high production—improves the fit substantially,[29] and produces coefficients for each production level that are significantly different from corresponding coefficients at different production levels. In each case, the response of net procurement to a change in the world price or production is less in the middle of the production range than it is at either extreme. The change in the coefficients becomes more dramatic as price variability increases.

The primary rationale for the decreased sensitivity to production and world price when production is close to normal is that the government would prefer several small price changes rather than a single, sharp rise in price. A policy that allows a sudden 50 percent change in price once in five years while holding prices constant in the other four is much worse than a policy that allows a 10 percent change in price in each of five years. Thus, the government preference for price stability is assumed to penalize deviations from the target price at an increasing rate (proportional to the square of the deviation). Consequently, the optimal policies do not force consumption to change as much when the price is close to the target as when the price is further from the target. An efficient government policy would do the same.

The implied degree of price sensitivity to world price and domestic production can be calculated. As stated in the methodology section above, for any given level of production, consumption is determined by net procurement. Thus, changes in production and world price affect consumption by the negative of their coefficients in the net procurement equations. Consequently, a coefficient of world price of 0.62 (Table 16, equation [2], price variability at 0.9) requires that consumption decrease by 6,200 tons if the world price increases by US$10 per ton. Assuming a base of 13 million tons for total consumption, this is a –6/13,000 = –0.046 percent change. Dividing this percentage by the price elasticity of –0.3 yields a required price increase of 0.15 percent, or Rs0.13 assuming a prior price of Rs85 per 40 kilograms. A similar calculation shows that the highest sensitivity of domestic price to world price, which occurs when price variability equals 5.9 and production is greater than 13.3 million tons, implies a price change of Rs1.12 per 40 kilograms when the world price goes up by US$10 per ton.

On the production side, a coefficient of production of 0.978—the highest in Table 16—implies that 97,800 tons out of a 100,000-ton increase in production would be procured. Consequently, consumption would rise by only 2,200 tons. Continuing as above, this implies a 0.017 percentage change in consumption and a –0.056 percentage change in price, or about Rs–0.05 per 40 kilograms. Similarly, the lowest coefficient of production in the table—0.471—implies a change of Rs–1.15 per 40 kilograms for the same 100,000-ton increase in production.

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[28] Pinckney 1988b presents results for Kenya that include sensitivity of net procurement to opening stocks. Similar regressions were run for Pakistan, but stock levels are so low that the contribution of the variable is negligible.

[29] The goodness of fit should be judged here by comparing regression standard errors rather than R^2's, since the range of the dependent variable changes in the partitioned regression.

Thus the optimal policies can be characterized quite well. The optimal domestic intervention of the government can be approximated by three linear relationships linking net procurement to production and the world price. The available supply that results from adding this net procurement to opening stocks should be exported unless world prices reach new record lows. The next section discusses how this characterization can aid in policy design.

Designing a Simple and Efficient Policy

It is not reasonable to propose that a government adopt the policies that result from an optimization routine. Such policies are difficult to describe and complicated to implement. The government has an objective of "simplicity of policy" that is difficult, if not impossible, to build into the objective function of an optimization procedure. Consequently, there is a trade-off between the complexity of a policy and its efficiency. There is a need to examine the elements that make the optimal policies more efficient, and to measure the degree to which each element contributes to decreasing fiscal cost while holding price variability constant. In this way, decisionmakers can decide whether or not the complexity introduced by an additional element is worth the associated savings in cost.

The regression results and the knowledge about the relative importance of stocks and exports suggest that there are five elements that make the optimal policies more efficient than the simplistic price band/buffer stock policies discussed above: stockholdings should be quite low; the maximum stock level should be sensitive to the world price, and decline to 0 at some world price; the domestic price should be sensitive to the world price; the domestic price should be sensitive to domestic production; and the degree of sensitivity to world price and production should depend on whether production is high, average, or low.

These elements are listed in order of increasing difficulty of implementation. The first two do not affect the domestic price and are thus invisible to most persons in the country.

Table 17 presents the results of adding these elements one by one to a simple price band/buffer stock policy. Figure 5 presents the same information in graphic form for the three levels of price variability, while Figure 6 details the results for the middle case. In the figures, the optimal policies (that is, policy 7) are connected by a line, and the other numbers correspond to the policy numbers in Table 17. When policies 2 and 5 do not appear in Figures 5 and 6, their costs are virtually equal to the costs of policies 3 and 4.

The improvements are much more dramatic for the relatively high price-variability case than for the low price-variability case. As prices become more stable, the scope for policy modifications becomes less. All policies with a price variability of zero would have a coefficient of 1.0 in the net procurement function; that is, all changes in production would be absorbed by changes in procurement in order to hold the price constant. Thus, the net procurement function for a simple price band/buffer stock policy begins to approach the same shape as the optimal policy when price variability approaches zero. Consequently, when price variability is 0.9, the gain in moving from a price band policy that never holds stocks (policy 2) to a policy in which net procurement is sensitive to both production and the world price at levels dependent on production (policy 6) is only Rs13 million annually. In contrast, when price variability is 5.9, the difference between these two types of policies is Rs63 million.

At all levels of price variability, lowering the maximum stock level in the price band/buffer stock scheme from 150,000 tons to zero saves large amounts, ranging

Table 17—Components of an efficient policy

Policy		Annual Cost	Improvement	Foreign Exchange Earnings
		(Rs million)		(US$ million)
(a) Price variability Rs 0.9 per 40 kilograms				
Policy 1 (a):	Simple price band with 150,000 metric tons buffer stock	207	. . .	4.0
Policy 2 (a):	Policy 1 with no buffer stock	186	22	5.6
Policy 3 (a):	Policy 1 with variable buffer stock, size dependent on world price	185	1	5.6
Policy 4 (a):	Policy 3 with price band adjusting to world price	178	7	8.8
Policy 5 (a):	Policy 4 adding sensitivity to domestic production	174	3	6.6
Policy 6 (a):	Policy 5 with degree of sensitivity to world price and production depending on production	173	1	6.7
Policy 7 (a):	Optimal policy	175	–2	6.6
(b) Price variability Rs 3.1 per 40 kilograms				
Policy 1 (b):	Simple price band with 150,000 metric tons buffer stock	134	. . .	4.4
Policy 2 (b):	Policy 1 with no buffer stock	108	26	6.0
Policy 3 (b):	Policy 1 with variable buffer stock, size dependent on world price	107	1	3.5
Policy 4 (b):	Policy 3 with price band adjusting to world price	75	32	10.9
Policy 5 (b):	Policy 4 adding sensitivity to domestic production	75	0	9.3
Policy 6 (b):	Policy 5 with degree of sensitivity to world price and production depending on production	71	4	9.4
Policy 7 (b):	Optimal policy	71	0	9.1
(c) Price variability Rs 5.9 per 40 kilograms				
Policy 1 (c):	Simple price band with 150,000 metric tons buffer stock	54	. . .	4.6
Policy 2 (c):	Policy 1 with no buffer stock	21	32	6.3
Policy 3 (c):	Policy 1 with variable buffer stock, size dependent on world price	21	0	6.3
Policy 4 (c):	Policy 3 with price band adjusting to world price	–34	55	11.8
Policy 5 (c):	Policy 4 adding sensitivity to domestic production	–32	–2	11.8
Policy 6 (c):	Policy 5 with degree of sensitivity to world price and production depending on production	–42	9	11.9
Policy 7 (c):	Optimal policy	–45	3	11.2

(continued)

Table 17—Continued

Notes: Policies 1(a), 2(a), and 3(a) have a price band of 1.12 percent. Policies 1(b), 2(b), and 3(b) have a price band of 3.82 percent. Policies 1(c), 2(c), and 3(c) have a price band of 7.72 percent.

Policies 3(a), 3(b), and 3(c) have a buffer stock of zero when the world price is above US$80 per metric ton. The maximum buffer stock for policies 3(a), 3(b), and 3(c) rises to 150,000 metric tons as the world price drops to US$30 per metric ton.

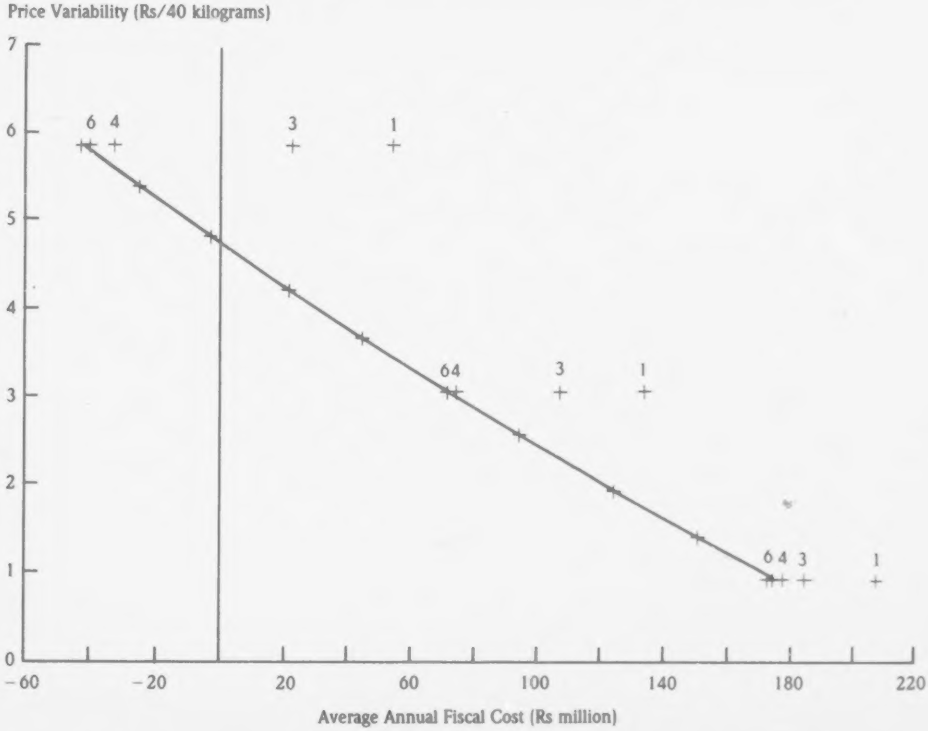
The price band for policy 4(a) is 0.78 percent. The domestic price is adjusted 13 paisa per 40 kilograms for every US$10 change in the world price. The price band for policy 4(b) is 3.12 percent. The domestic price is adjusted 45 paisa per 40 kilograms for every US$10 change in the world price. The price band for policy 4(c) is 6.82 percent. The domestic price is adjusted 85 paisa per 40 kilograms for every US$10 change in the world price.

In policy 5(a) the domestic price moves 13 paisa per 40 kilograms for each US$10 change in the world price, and 9 paisa per 40 kilograms for each 100,000-metric-ton increase in production. In policy 5(b) the domestic price moves 45 paisa per 40 kilograms for each US$10 change in the world price, and 32 paisa per 40 kilograms for each 100,000-metric-ton increase in production. In policy 5(c) the domestic price moves 85 paisa per 40 kilograms for each US$10 change in the world price, and 63 paisa per 40 kilograms for each 100,000-metric-ton increase in production.

In policies 6(a), 6(b), and 6(c) the domestic price moves with respect to the world price and domestic production in accord with regressions (3)(a), (3)(b), and (3)(c) of Table 16.

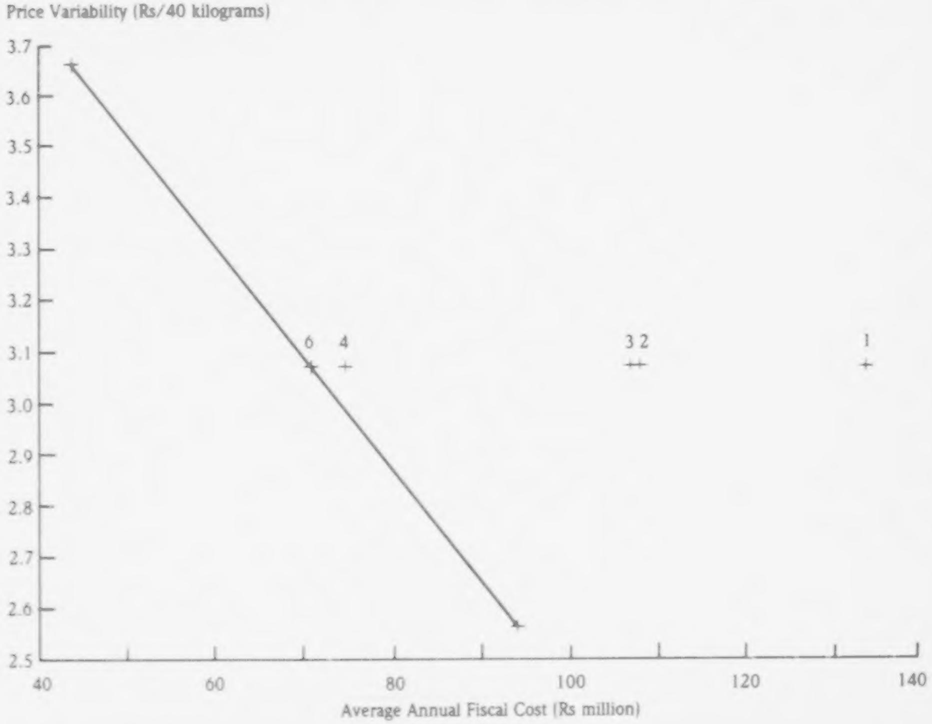
Parts may not add to totals because of rounding.

Figure 5—Efficient policy adjustments for three levels of price variability



Notes: Policy 1 is the price band policy with a buffer stock of 150,000 metric tons. Policy 3 is the price band policy with a variable-sized buffer stock whose size is dependent on the world price. Policy 4 is policy 3 with a price band that moves with changes in the world price. Policy 6 is policy 4 with the price band sensitive to production and world price, but with the degree of sensitivity dependent on the level of production.

Figure 6—Efficient policy adjustments for middle level of price variability



Notes: Policy 1 is the price band policy with a buffer stock of 150,000 metric tons. Policy 2 is the price band policy with no buffer stock. Policy 3 is the price band policy with a variable-sized buffer stock whose size is dependent on the world price. Policy 4 is policy 3 with a price band that moves with changes in the world price. Policy 6 is policy 4 with the price band sensitive to production and world price, but with the degree of sensitivity dependent on the level of production.

from Rs22 million to Rs32 million annually. Changing the policy by allowing some stocks to be held when the world price is low (policy 3) has virtually no effect on the cost, since years with the world price below US$80 per ton are few.

Allowing the domestic price to respond to the world price (policy 4) has the greatest effect of any single policy change for the higher levels of price variability. This policy adjustment also exhibits the largest variation in effect, as shown in Figure 5. The improvement from policy 3 to policy 4 is only Rs7 million annually when price variability is 0.9; the improvement is Rs32 million and Rs55 million annually when price variability is 3.1 and 5.9, respectively. This disparity is explained by the large difference in sensitivity to the world price among the different optimal policies. When price variability is 5.9, domestic consumption responds more than six times as much to a change in the world price as when price variability is only 0.9. The policy change is more dramatic and consequently more effective at higher levels of price variability.

Adding sensitivity to domestic production—moving from policy 4 to policy 5—has only a small effect and actually produces an inferior policy when price variability is 5.9. In interpreting this result, it is important to understand the differences between policy 4 and policy 5. Policy 4 consists of a domestic price band that moves up and down depending on the world price. Holding world price constant, the net procurement function looks like the one shown in Figure 7. If the price is to be held between P_{max} and P_{min}, the net procurement function has a slope of one when production is less than Q_{low}, a slope of zero when production is between Q_{low} and Q_{high}, and a slope of one again when production is above Q_{high}. On the other hand, policy 5 basically implements the net purchases function estimated in equations (2) of Table 16, which is a straight line when world price is constant. Given the pattern for the optimal net purchases function shown in Figure 4, it is clear that the function implied by the price band policy is closer to optimal than the straight line of policy 5. As price variability declines, however, the middle section of the optimal policy's net procurement curve becomes less flat, and a straight line eventually becomes a better approximation than the zero-sloped segment of a price band policy.

The policy that is sensitive to the world price alone—policy 4—is thus not an implementation of the net procurement function estimated in equations (1) of Table 16. The sensitivity to world price estimated in the equations is added and brings about a large increase in efficiency. A degree of sensitivity to production is included in all of policies 1 through 4—but not in equations (1)—by the existence of a price band. This explains how the fit of equations (2) can be so much better than equations (1), yet policy 5 is no improvement over policy 4.

Policy 6 attempts to correct the shape of the net procurement equation of policy 5 by using the regression results from equations (3a), (3b), and (3c) of Table 16 to allow for different degrees of sensitivity to production and world price over different ranges of production.[30] For all levels of price variability, policy 6 leads to some improvement. The improvement is small, however, ranging from Rs1 million to Rs7 million annually.

The resulting policies are very close in efficiency to the optimal policies. It is thus possible to be confident that policy 6 includes all of the important components of the optimal policy. Indeed, with a price variability of 0.9, policy 6 is actually superior to the "optimal" policy.

Figure 8 explains how this anomaly is possible. Recall that the optimal policies are actually interpolated policies from a discrete optimization process. In the figure, suppose that the truly optimal relationship between production and net procurement is the straight line, but only points on the grid are considered by the discrete optimization procedure. Thus, the points marked with boxes are chosen by the procedure as being superior to all other considered points. These points are the closest points on the grid to the straight line. The interpolated policy will then consist of the grid points and the segments connecting the points. Therefore, a linear regression estimated from the interpolated policy will produce a line that exactly coincides with the truly optimal policy, and a simulation of this policy will produce a superior result to a simulation of the interpolated "optimal" policy.

Although it would be rare for the truly optimal relationship to coincide exactly with the regression results, it is quite possible for the regression line to be closer to the truly optimal relationship than the interpolated policy. This is more likely to be true when the truly optimal relationship loses its curvature as price variability moves toward zero. This explains the anomalous result from Table 17.

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[30] Tests were conducted modifying policy 4 by allowing the sensitivity of net procurement to world price to be responsive to different levels of production. The resulting policies were no improvement over policy 4.

Figure 7—Net procurement function implied by price band policy

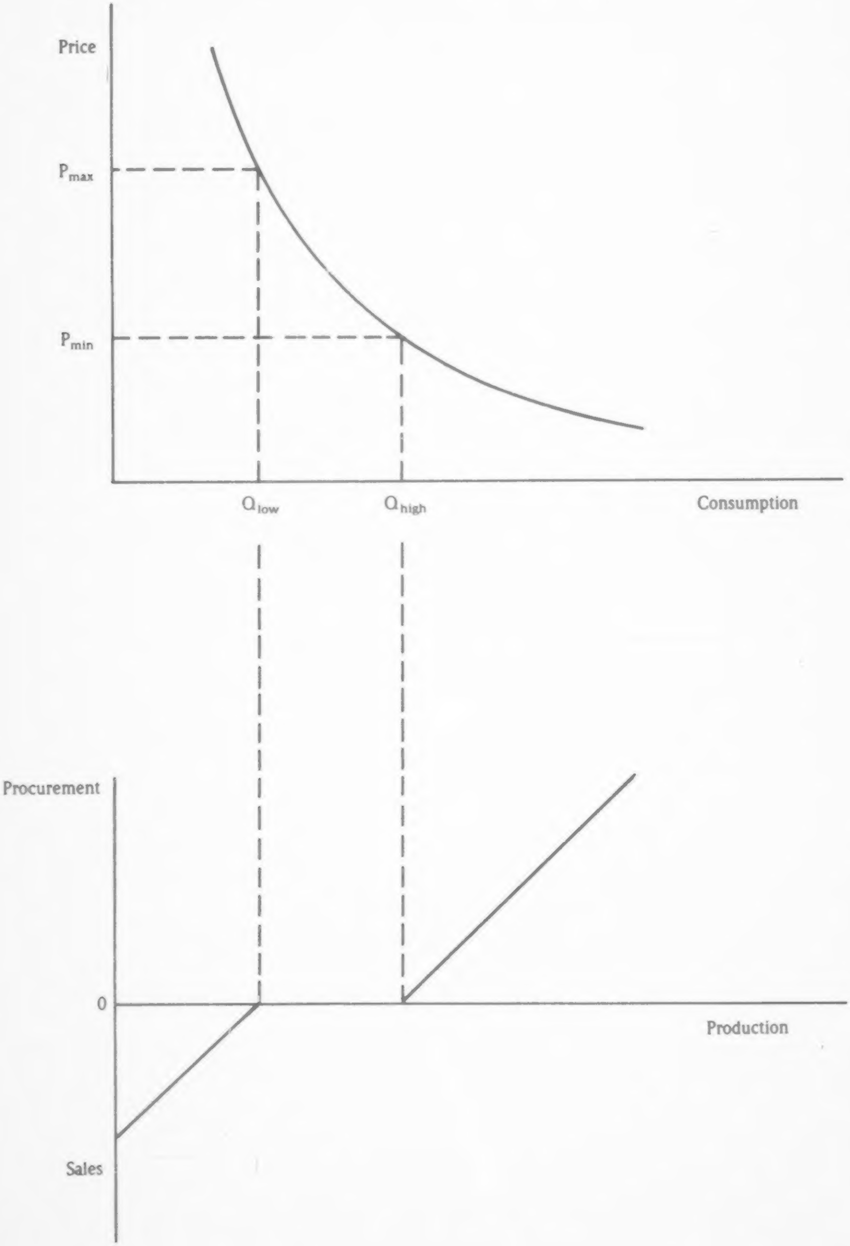
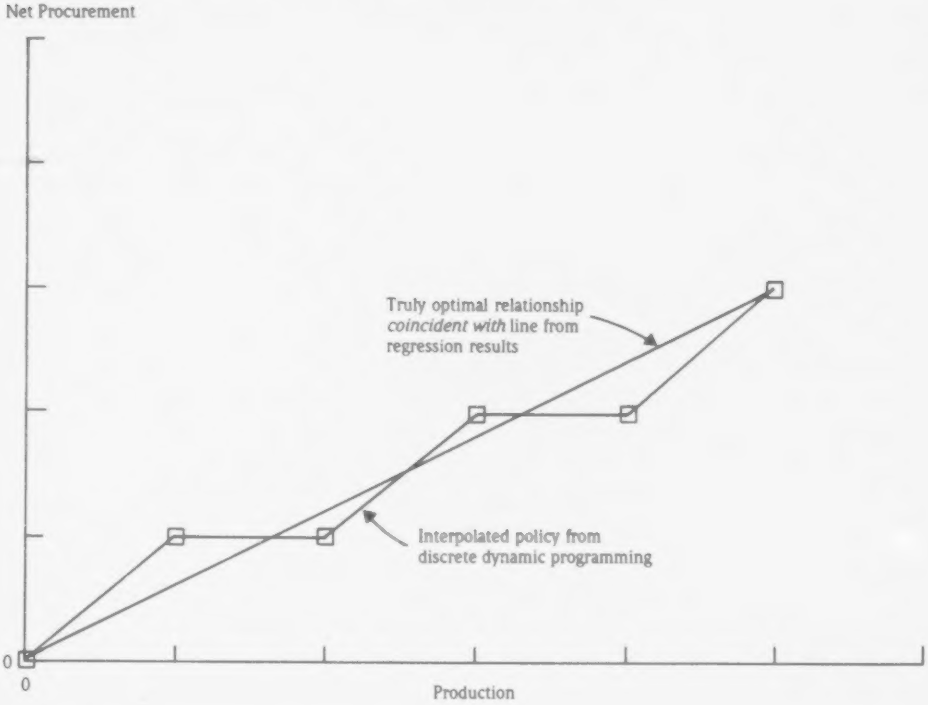


Figure 8—Stylized optimal net procurement function



Thus, it is possible to delineate the differences between simple price band/buffer stock policies and optimal price, storage, and trade policies. The elements of an efficient policy can be introduced one by one into a price band policy, with the added efficiency of each component measured. The implications of the modeling effort for policy in Pakistan are discussed below.

Policy Implications

The two most important policy recommendations of this analysis are that Pakistan should not hold interannual supply stabilization stocks at present world prices and should not build extra storage capacity for such stocks.

These recommendations are robust for many different changes in assumed parameters, particularly since most parameters were chosen to bias results somewhat toward higher levels of storage. Thus, even though it is impossible to be certain about, say, the amount of food aid Pakistan will receive, even when the extreme assumption of no food aid is made, Pakistan still should not hold interannual stocks.

The savings that accrue from following these recommendations far outweigh the savings for Pakistan that result from modifying the domestic price structure so that it approximates an optimal policy. Nevertheless, there are significant benefits shown in Table 16 and Figure 8, particularly if the government's relative preferences for low fiscal cost and price stability lead to a choice for price variability in the higher range of the tables. Once stock sizes are reduced, the largest gain in efficiency comes from allowing the domestic price to respond to the world price. As pointed out above, the degree of sensitivity is not particularly large, with a US$10 change in the world price leading to a change in the domestic price between Rs0.13 and Rs1.12 per 40 kilograms for the levels of price variability considered here.

World prices are taken into account by the Agricultural Prices Commission in making a recommendation to the government each year. This recommendation, however, is based on September world prices for a crop year that will begin the next April. World prices in dollars can swing widely in seven months; indeed, excluding the large 1972/73 price increase, the standard deviation of the percent changes in the world price from September to April is 80 percent as high as the standard deviation of the percent changes in the annual price.[31] From 1970 to 1987, the range of percent changes in the world price from September to April is from -18 to $+32$ percent; in 15 out of the 18 years, the absolute change has been larger than US$10 per ton (in 1986 dollars). Because of changes—usually depreciations—in the nominal exchange rate, the world price expressed in rupees can vary even more. Even though these exchange rate changes are to some extent under the control of the government, they are unknown to the agricultural policymakers setting the procurement price.

One way to bring the most recent world price information into the pricing mechanism would be to announce a procurement price at planting time that is calculated assuming a significant fall of 15 percent in the world price. Given the past history of world price changes, it is unlikely that the world price would fall more than this amount between September and April. In mid-April, before procurement begins, the government would announce a "world price bonus payment" to be paid above the procurement price for all wheat procured. The amount of the bonus would be calculated as follows:

$$D = [WP_1 - (0.85 \cdot WP_0)] \cdot S, \tag{14}$$

where

D = world price bonus payment,
WP_0 = world price in September of the last year,
WP_1 = world price on April 15, and
S = sensitivity of the domestic price to the world price.

For example, suppose that the world price in September is US$120 per ton. Given this world price, the government's desired procurement price is Rs85 per 40 kilograms. Suppose also that the government is aiming at a price variability of 5.9, and thus the sensitivity of the domestic price to the world price should be Rs1.120 per US$10 change, or Rs0.112 per US$1 change. Consequently, the procurement price announced at planting time would be

$$85 - 0.112 \cdot (0.15 \cdot 120) = 85 - 2.02 = \text{Rs}83,$$

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[31] U.S. Gulf Port prices for No. 2 hard winter wheat are used in these calculations.

to the nearest 5 paisa.[32] Suppose then that the actual price on April 15 is US$130 per ton. The world price bonus payment to be added to the Rs83 procurement price would be

$$(130 - 102) \cdot 0.112 = \text{Rs}3.15,$$

to the nearest 5 paisa. The total amount paid to farmers would thus be Rs86.15 per 40 kilograms.

These price movements are not large, yet they lead to significant savings in fiscal cost. If the desired price variability level is lower than 5.9, the degree of sensitivity to world price will be lower still.

The estimates of the savings from allowing the domestic price to be sensitive to domestic production are small. These estimates, however, may not be accurate given Pakistan's present seasonal price policy. The price band policies used in the simulations of policies 1 through 4 assume that the government selling price covers the procurement price plus all incidentals plus the price band. Under such a policy, the average price for the year can vary significantly from year to year. But for this to occur, the price band for even the lowest price variability level would require a selling price more than 50 paisa per kilogram above the procurement price. For 1987/88, this gap was only 8 paisa per kilogram. With such a small gap, the average annual domestic price would be virtually constant from year to year, regardless of the size of production.

If this gap cannot be raised above government costs, the benefits of allowing official prices to be sensitive to domestic prices will be much larger than measured. Sensitivity to production can be built into the system through a bonus payment system, as in the case of sensitivity to world price. A "production bonus payment" could be added to the world price bonus payment. As in the case of the world price bonus payment, the announced procurement price would have to be the lowest price offered under any circumstances. Thus it would be calculated based on the two events that would lower the optimal domestic price: a fall in the world price and an abundant crop.

Suppose, for example, that expected production for next year is 13 million tons. World price in September is US$120 per ton as above. Given the variability of production of 0.06 measured in Chapter 3, the standard deviation of production would be

$$0.06 \cdot 13 \text{ million} = 780{,}000 \text{ tons.}$$

As in the case of the world price differential, the government wants to announce the lowest price at which it would buy wheat. It consequently assumes high production for the present crop year. A production level of 1.28 standard deviations above the mean would occur about 1 year in 10, while a level 1.64 standard deviations above would occur 1 year in 20. For illustrative purposes, the lower level is chosen. This works out to

$$1.28 \cdot 780{,}000 = 1 \text{ million tons,}$$

to the nearest 5,000 tons.

As above, suppose that the government's desired procurement price at the world price of US$120 and a production level of 13 million tons is Rs85 per 40 kilograms.

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[32] One hundred paisa equal one rupee.

Suppose also that the desired price variability is 5.9 and the government chooses to implement the more complicated, tripartite net purchases function. The regression results from Table 16 indicate that consumption would increase by

$$(1 - 0.471) \cdot 300 + (1 - 0.827) . 700 = 280{,}000 \text{ tons.}$$[33]

This translates into a percentage price change of

$$280/13{,}000/0.3 = 7.2 \text{ percent,}$$

or Rs6.10 per 40 kilograms. Given that the world price adjustment equals Rs2.00, the announced procurement price would be

$$85 - 2 - 6.10 = \text{Rs}76.90 \text{ per 40 kilograms.}$$

Now, assume that the early April forecast of production is 12.9 million tons. This forecast is used to compute the production bonus payment. Although the April forecast will deviate from actual production to some extent, it includes much more information than was known at the time of announcing the procurement price. The bonus payment is then equal to the previously calculated Rs 6.10 (which is what the production bonus payment would equal if production were 13 million tons) plus an adjustment for the shortfall below expected production. The additional change in consumption is

$$(1 - 0.471) \cdot (13.0 \text{ million} - 12.9 \text{ million}) = 53{,}000 \text{ tons.}$$

This amount implies a price change of

$$53/13{,}000/0.3 = 1.36 \text{ percent,}$$

or Rs1.15 to the nearest 5 paisa.

The total production differential is thus 6.10 + 1.15 = Rs7.25 per 40 kilograms. The total price paid to farmers is the procurement price plus the production bonus payment plus the world price bonus payment. Assuming the world price bonus payment is Rs3.15 as above, the total payment is

$$76.90 + 3.15 + 7.25 = 87.30.$$

On the other hand, if production had ended up being 14 million tons or more, the production differential would have been zero and the total paid to farmers would have been

$$76.90 + 3.15 = 80.05.$$

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[33] Since the coefficients are for net procurement, the increase in consumption equals 1 minus (increase in net procurement). The 1-million-ton increase in production is broken down into the first 300,000 tons and the second 700,000 tons because of the partitioning of the net procurement function.

The important point to note here is not the exact calculations, but the existence of sensitivity to domestic production. If the amount of sensitivity shown in these calculations were deemed too large, a lower level of price variability could be chosen (albeit at higher levels of fiscal expenditure). But if the government selling price is to remain below the government cost, some mechanism such as this needs to be instituted to allow a degree of sensitivity of price to production.

In addition, note that both the producer price and the consumer price must respond to the world price and domestic production in order to reap the benefits measured in this chapter. Thus, if a world price bonus payment is added to the procurement price, the government selling price will have to go up by a corresponding amount. Simulations of these policies holding the consumer price constant while the procurement price changes show that virtually all of the benefits disappear.

It is possible to approximate the effect of such price changes on consumption by the poorest households. Although the policies considered here do not significantly change average price across years, it is difficult for the poorest consumers to transfer gains in real income in low-price years to future, high-price years. Indeed, a drop in consumption that leads to death and disease cannot be offset by later increases in income and consumption. And as shown in Mellor 1978, the poor are likely to absorb most of the required change in consumption.

Nevertheless, the income and calorie effects on the poorest groups of the price changes considered here are modest. For the highest level of price variability modeled here—Rs5.90 per 40 kilograms—in 19 out of 20 years, the change in price would be less than Rs10.00 per 40 kilograms, or 12.5 percent. Since the poorest consumers spend about 12.0 percent of their income on wheat and wheat products, the decline in real income would be about 1.5 percent. If the income elasticity of calorie consumption is 0.5, this implies a reduction in calories of 0.75 percent, or less than 15 calories per person per day.[34] Lower allowable levels of price variability would clearly have an even smaller impact on consumption. Although it is never desirable to decrease incomes of poor people, such a small impact seems unlikely to cause such extreme short-term effects that it cannot be offset by higher incomes in low-price years.

Moreover, the policy conclusions of this report concern the *method* for stabilizing prices more than the *degree* of stability. The government clearly has reasons for stabilizing prices other than consumer welfare. The results presented in this chapter concerning efficient policy design are of relevance regardless of the particular desired level of price stability.

Conclusions

The coefficient of variation of Pakistan's wheat production is about 6 percent. Using stocks to stabilize consumption in the presence of this variability is inefficient unless world prices are less than US$80 per ton. Given any reasonable assumption about future world prices, the value of building additional storage capacity for interannual supply stabilization purposes is much less than the cost. Other than minimizing this type of stockholding, the most profitable change in policy would be allowing the domestic price to reflect changes in the world price. This degree of sensitivity is not large, and could be accomplished by paying a "world price bonus payment" above the procurement price. If seasonal price policy, as examined in Chapter 5, does not allow for a release price above government cost, the benefits of allowing the official price to respond to domestic production increase substantially. In that case, a strong rationale exists for instituting a "production bonus payment" also.

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[34] This assumes that the decline in calorie consumption results from the decline in real income rather than from the shift in relative prices. In other words, with real income (and thus utility) held constant, poor consumers do not decrease calorie consumption when relative prices change. This would appear to be a reasonable assumption for consumers who already have a calorie deficit.

5

SEASONAL PRICE POLICY AND STORAGE DEMAND

The previous chapter has analyzed the demand for interannual supply stabilization stocks, the type of storage demand most often analyzed in the literature. The conclusion is that, at the end of the market year, Pakistan should not hold stocks to buffer a possible shortfall in production during the next market year. Thus, one element of storage demand is zero. This does not imply, however, that the government should never hold stocks of any kind. If the government desires to stabilize seasonal price swings, significant stocks could be purchased at harvest time and sold during the remainder of the year. As pointed out in Chapter 2, there is some reason to believe that such within-year stocks for seasonal distribution could be quite large. Thus, it is necessary to analyze the determinants of procurement size and offtake demand in order to assess the total demand for storage in the system.

It is clear that changing the guaranteed procurement price will change the amount procured, holding crop size constant. Less clear, but equally important, is the relationship between the permitted seasonal price rise and procurement size. Holding production and the procurement price constant, the amount of wheat procured by the government will be an inverse function of the allowed seasonal price rise. Showing that this effect is important and measuring its size is the subject of the remainder of this chapter.

The government of Pakistan has only recently begun to cap the seasonal price rise as an alternative to selling wheat through the ration shop system. Early in 1987, the government announced that it was phasing out its ration shop system, which had been in place for more than 40 years. Instead of providing set quantities at a highly subsidized price to a limited segment of the population, the new policy requires the government to sell all that the market will buy at a set price.[35] This change fundamentally alters the relationship of the Pakistan government to the private wheat market.

Historically, the private wheat market has been officially sanctioned and supported by the government, unlike the situation in many less-developed countries where private markets have been tolerated but are in fact illegal. The result has been an active private market in wheat trading. In past years, prices in the private market have shown a marked seasonal pattern, with harvest prices close to the government procurement price, afterward rising an average of 18 percent to a peak in January. Unless the difference between the government buying and selling prices is close to this figure of 18 percent, the expected seasonal price rise would be less. Thus expected returns to storage would be lower than in the past, and private agents consequently would store less. The result would be larger procurement and higher demands on government

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A version of this chapter entitled "The Effects of Pricing Policy on Seasonal Storage of Wheat in Pakistan" has been submitted for publication in *Agricultural Economics.*

[35] Since most of the supplies earmarked for the ration shops did not reach the intended beneficiaries but were diverted into the open market, the change in policy was not as dramatic as it appears. See Alderman, Chaudhry, and Garcia 1988.

storage facilities. Thus, this topic is of direct relevance to establishing the appropriate size of government storage facilities.

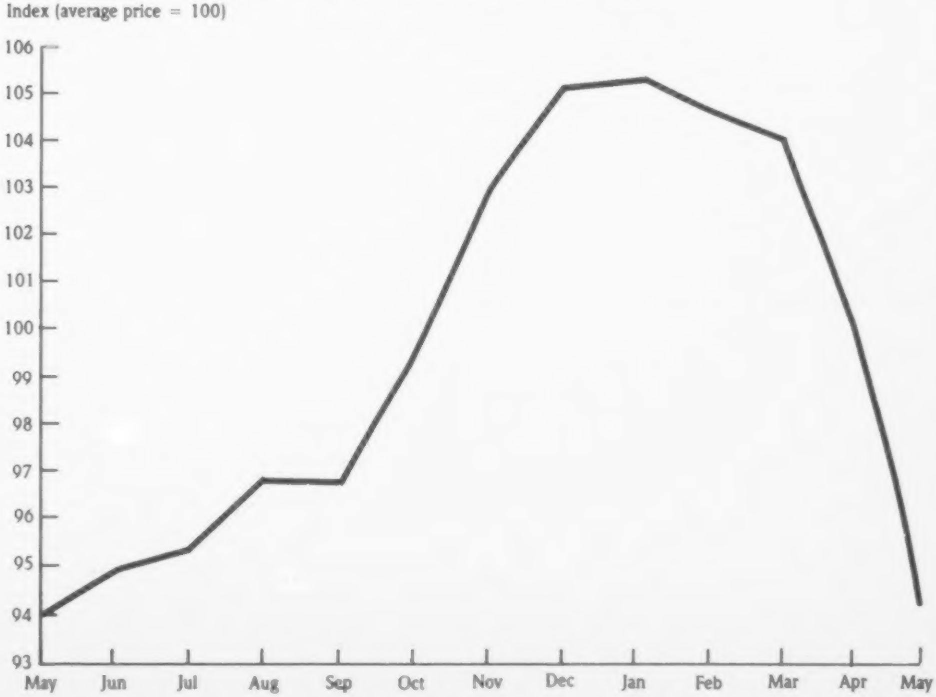
But how important is the private sector in seasonal storage in Pakistan? Does the change in price policy make any substantial difference? What are the implications of this policy in terms of government cost, government procurement, and the growth of private marketing activity?

These questions are addressed in the following way. An examination of the seasonal pattern of prices that have held historically is followed by an estimation of the importance of private-sector seasonal storage. This is followed by the development of a model for examining these issues, using Working's (1949) theory of the price of storage. The model is then estimated, validated, and used to measure fiscal cost, procurement, and private storage under different policy alternatives. Finally, sensitivity analysis and conclusions are presented.

The Historical Seasonal Price Pattern

Figure 9 presents the historical seasonal price pattern, which is constructed using a weighted average of separate price series for Faisalabad, Hyderabad, Lahore, Multan,

Figure 9—Seasonal price rise of wheat in Pakistan, 1979-87



Source: Data from the Federal Bureau of Statistics, Islamabad.
Note: The price pattern is constructed with a weighted average of separate price series for Faisalabad, Hyderabad, Lahore, Multan, Okara, and Sargodha.

Okara, and Sargodha. Since the scale is the average ratio of each month's price to a 12-month moving average, the 12 percent price rise presented in the figure can be considered a real price rise.[36] The figure shows slowly rising prices during the procurement season of May, June, and July, followed by rapid increases in October, November, and December, with prices leveling off before declining dramatically in April and May.

In order to consider nominal prices and the dispersion of price rises across markets and years, Table 18 presents the percentage price rise for each of these six wholesale markets from 1976/77 to 1986/87.[37] In the 10 years prior to 1987, the lowest nominal seasonal price rise in these six markets was 5.3 percent in Hyderabad in 1985/86.[38] The price rise during 1986/87 was considerably smaller, perhaps because the announcement of the policy change was made during the normally high-price months. The rise in market year 1977/78 was exceptionally high, as prices rose dramatically in all markets in the months following the declaration of martial law. Aside from that abnormal year, the highest price rise was 29.8 percent in Okara in 1978/79.

Three-fourths of all the price rises across markets and years from 1978/79 to 1985/86 were between 10 and 25 percent, while price rises greater than 10 percent

Table 18—Seasonal price rises in selected markets, 1976/77-1986/87

Year	Faisalabad	Hydersbad	Lahore	Multan	Okara	Sargodha	Weighted Average
				(percent)			
1976/77	16.5	11.4	9.5	15.6	9.8	17.6	13.1
1977/78	62.3	n.a.	44.3	47.5	58.7	61.9	n.a.
1978/79	13.3	20.5	21.8	24.4	29.8	18.3	22.6
1979/80	12.7	22.6	17.6	7.5	17.7	19.6	14.9
1980/81	10.7	10.2	7.3	5.9	8.9	15.3	8.5
1981/82	22.1	27.3	24.5	20.8	22.7	25.7	23.3
1982/83	14.8	9.4	17.1	17.6	18.5	20.3	16.0
1983/84	18.7	21.1	14.6	17.2	16.4	21.8	17.8
1984/85	18.6	11.1	24.2	27.7	27.6	24.2	22.8
1985/86	18.6	5.3	20.7	15.3	15.4	14.5	14.6
1986/87	6.5	7.1	6.1	6.2	2.7	6.1	5.7
1977-87 average	19.5	n.a.	18.9	18.7	20.8	22.3	n.a.
1979-86 average	16.2	15.9	18.5	17.1	19.6	20.0	17.6

Source: Data from the Federal Bureau of Statistics, Islamabad.
Notes: n.a. means not available. The percentages are derived from prices for the three usually highest-priced months divided by those for the three usually lowest-priced months.

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[36] The index was developed by constructing a weighted average time series of wholesale prices for the six markets from 1979 to 1987, with the weights determined by average share in total procurement, since this should reflect the extent of wheat available for storage. A seasonal index was then constructed for this weighted average series using the ratio to moving average method. Data from the Federal Bureau of Statistics, Islamabad, were used in the analysis.

[37] To minimize the effects of any single month's data, the table is presented as the percent rise from the three usually lowest-price months (May, June, and July in the Punjab; April, May, and June in the Sind) to the three usually highest-price months (December, January, and February for the Punjab; November, December, and January for the Sind).

[38] The data for Hyderabad for 1977/78 show a price *decline* during a period when the smallest increase in any other market listed here was 44 percent. These data are considered suspect and consequently are not included in the analysis.

occurred 90 percent of the time. Averages by market during this period range from 15.9 percent for Hyderabad to 20.0 for Sargodha. Weighting the price rise for each market by the share of procurement for that market yields an average price rise of 17.6 percent.

In sum, the previous system gave private agents a return to storage that was reasonably secure. Although there is dispersion across markets and years, there was a price rise of 10 percent or more in almost all cases aside from the year in which the new policy was announced.

The Size of Private Storage

The normal seasonal pattern of price rises has given the private sector, particularly surplus farmers, an incentive to store wheat from harvest until the later months in the marketing year. Knowing how much has been stored in different months in different years, however, is difficult, as there have been no national surveys of farmers, traders, and millers that collected such data.

Table 19 presents a monthly time series of minimum estimates of private storage. It was constructed with the aid of the following four assumptions: market arrival of production is assumed to be distributed across months in the same proportion as procurement for each year; losses of 10 percent are incurred at the time of market arrival; private stocks at the end of April from the previous year's harvest are assumed to be zero; and per capita consumption is assumed to be constant across months within a marketing year, with total consumption in the marketing year equal to production less 10 percent, plus offtake from government stocks, minus procurement. These last three assumptions are simplifications that bias the estimate of private stocks downward. The estimate is thus a lower bound for private storage.

Given these assumptions, private storage at the end of any month, PS_t, is equal to private storage at the end of the previous month, PS_{t-1}, plus net production, Q_t, plus offtake, O_t, minus procurement, PC_t, minus consumption, C_t:

$$PS_t = PS_{t-1} + Q_t + O_t - PC_t - C_t. \tag{15}$$

As in the annual model, exports and imports affect private stocks and consumption only through procurement and offtake, since the government controls all foreign trade. The results of applying equation (15) to the monthly data are shown in the last column of Table 19. Private storage is quite large, with 5-6 million tons held at the end of June of each year.

These private stocks are held for at least four purposes. Some traders are holding for later sale; millers are holding for later processing; farmers are holding for later sale; and farmers as well as consumers are holding for own consumption. It would be useful to know how much of this private storage is held for each of these purposes. Unfortunately, this is not possible both because of a lack of microlevel data and because the farmers themselves may shift their intended use depending on prices. The most that can be said about the breakdown is that farmers hold most of the stock at the end of July, since the Agroprogress and Indus (1986) study reports that total storage capacity of traders and millers is only 1.1 million tons.

Table 19—Estimated private storage of wheat, 1983-87

Year/Month	Annual Production	Market Arrival of Production	Procurement	Offtake	Estimated Private Storage
			(1,000 metric tons)		
1983/84	12,414				
May		4,535	1,551	235	2,570
June		5,106	1,746	147	5,205
July		957	327	146	5,106
August		211	72	179	4,546
September		70	24	181	3,894
October		1	0	217	3,231
November		...	...	263	2,610
December		...	...	316	2,040
January		...	...	385	1,537
February		...	...	399	1,046
March		...	...	420	573
April		452	105	363	388
1984/85	10,882				
May		7,523	1,747	186	5,430
June		1,637	380	172	5,937
July		142	33	227	5,348
August		39	9	243	4,693
September		...	...	266	4,030
October		...	...	285	3,383
November		...	...	306	2,754
December		...	...	366	2,184
January		...	...	441	1,686
February		...	...	397	1,141
March		21	5	431	644
April		1,376	331	372	1,114
1985/86	11,703				
May		7,864	1,892	254	6,399
June		1,023	246	220	6,452
July		229	55	233	5,913
August		21	5	229	5,210
September		...	...	241	4,500
October		...	...	259	3,806
November		...	...	285	3,135
December		...	...	317	2,494
January		...	...	352	1,886
February		...	...	361	1,284
March		17	7	378	707
April		701	282	345	504
1986/87	13,916				
May		7,343	2,952	297	4,279
June		3,473	1,396	231	5,672
July		853	343	247	5,512
August		129	52	244	4,913
September		7	3	255	4,251
October		...	...	265	3,591
November		...	...	276	2,941
December		...	...	311	2,322
January		...	...	351	1,742
February		...	...	347	1,156
March		6	2	432	655
April		921	325	389	702

Source: Author's calculations; data from Federal Bureau of Statistics and Ministry of Food, Agriculture, and Cooperatives, Islamabad.

The Relationship Between Private Storage and Price Rises

The Supply-of-Storage Model

A 12-month model with no uncertainty is used here to estimate the effects of government price policy on private storage in a normal production year. The first several equations parallel those of the interannual model in Chapter 4. Supply, S_t, in any month equals the opening private stocks, PS_t, plus the amount harvested during the month, Q_t, plus offtake from government stocks, O_t:

$$S_t = PS_t + Q_t + O_t, \tag{16}$$

where

$$Q_t = 0 \text{ for } 3 < t < 12.$$

Time, t, equals one in the largest harvest month, May. Harvested amounts, Q_t, are exogenous and equal to zero between August and March. Supply is apportioned between carryout private stocks, PS_{t+1}, consumption, C_t, and government procurement, PC_t:

$$S_t = PS_{t+1} + C_t + PC_t. \tag{17}$$

Consumption is a function of price, P:

$$C_t = f(P_t), \tag{18}$$

while offtake and procurement are functions of price and the release, PR, and procurement, PP, prices. Procurement is zero when the price is above the procurement price, but offtake does not go below a minimal level that is required to support the population in farflung, permanent-deficit areas:

$$PC_t = g_1(PP, P_t), \tag{19}$$

where

$$g_1 = 0 \text{ for } PP < P_t, \text{ and}$$

$$O_t = g_2(PR, P_t), \tag{20}$$

where

$$g_2 = O_{min} \text{ for } PR > P_t.$$

The remaining equation is for the supply of storage. Since this is a certainty model, at time t the expected price for time t + 1 equals the eventual price at time t + 1. Therefore, the amount held in storage at time t is a function of the present price and next period's price. In addition, this storage function may shift across months, particularly in an economy with a large number of subsistance producers:

$$PS_t = h_t(P_t, P_{t+1}). \tag{21}$$

Finally, April prices and storage in successive years are assumed to be equal, since this is a certain, normal-production-year model:

$$PS_0 = PS_{12}, \tag{22}$$

$$P_0 = P_{12}. \tag{23}$$

Setting equations (16) and (17) equal to each other and substituting yields:

$$PS_t + Q_t + g_2(PR, P_t) = PS_{t+1} + f(P_t) + g_1(PP, P_t). \tag{24}$$

Using equations (21) through (24), the policy model reduces to a set of 24 nonlinear equations in 24 unknowns: one balance equation and one storage equation for each month.

In applying the model, the demand function is assumed to be constant elasticity with an own-price elasticity of -0.25. This is a reasonable guess for a staple food in a poor country, although some recent estimates are considerably higher (Alderman 1988a). Results are insensitive to the size of this parameter. Prices are calibrated in rupees per 40 kilograms, a standard unit of measure in Pakistan.

The modeling for the supply-of-storage equation is key to producing a reasonable approximation of reality. Most analysts make a distinction between "working" or "pipeline" stocks and "speculative" stocks, with only the latter held sensitive to changes in expected (or futures) prices. Speculative stocks are held only when the expected change in price is greater than the total cost of storage, including physical costs and interest charges (or the appropriate opportunity cost of capital). This is the normal intertemporal arbitrage assumption made, for example, by Lowry et al. (1987) in one of the few interannual storage studies to take seasonal storage into account. The implication of such an assumption for a certainty model is that whenever stocks are held, the price rise equals the cost of storage. The result carries over to models with uncertainty when expectations are rational, as in the Lowry et al. article.

Expected price increases equal to full carrying charges, however, are rarely found empirically. The seasonal price pattern for Pakistan shown in Figure 9, which holds in the presence of large stocks, does not support such a model. Nor is support forthcoming from the large number of studies of futures markets relating the price spread between contracts to the size of stocks (Working 1949; Brennan 1958; Gray and Peck 1981).

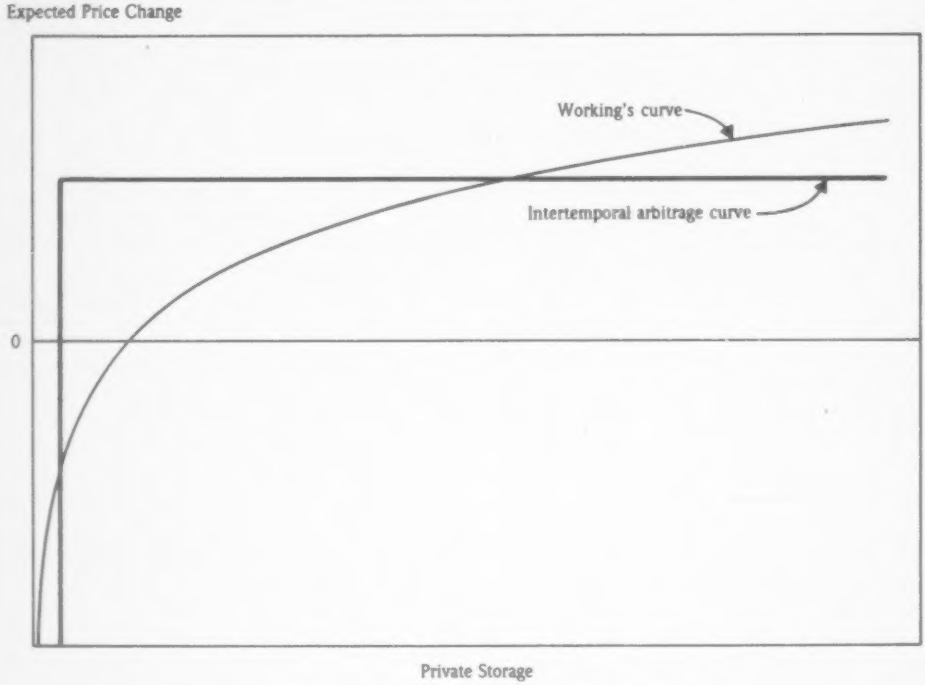
Figure 10 presents two stylized versions of the supply-of-storage function, both the general shape found in the empirical studies and the shape that results from the normal intertemporal arbitrage assumption. The key difference is that in Working's formulation, there is no clear distinction between pipeline stocks and speculative stocks. Stockholding is an increasing function of the difference between the expected price (or futures price in most of the empirical work) and the present price, even if the difference is negative. Thus the empirical studies show that if prices are expected to fall in the next month, market actors will hold fewer stocks than if prices are expected to remain constant. The normal intertemporal arbitrage assumption, on the other hand, assumes that private stockholding would be the same in those two circumstances.

Working argues that stockholding is generally not an isolated investment, but part of a larger processing or marketing activity. Stocks have a "convenience yield" or "accessibility value" that increases as total stocks in the economy decrease.

For the purposes of this paper, it is assumed that there is a convenience yield to stocks, and that the shape of the supply-of-storage curve follows that found in the empirical studies. The logarithmic functional form is used. Thus, equation (21) becomes

$$PS_t = (A_t)\exp[B_t(P_{t+1} - P_t)], \tag{25}$$

Figure 10—Stylized supply-of-storage curves



where A_t and B_t are time-specific parameters to be estimated, and exp is the exponential function. See Peck 1977/78 for another use of supply-of-storage curves in the analysis of government stocking schemes.

Estimation of the Model

Two assumptions are necessary in order to estimate the supply-of-storage equation above. First, the expected price change between any two months historically is assumed to equal the average percentage price change between those two months between 1979 and 1987, as shown in Figure 9. Second, it is necessary to assume that either the A parameter or the B parameter in equation (25) is stable across months. The latter option is chosen here, implying that a 1 rupee increase in P_{t+1} leads to the same percentage increase in PS_t, regardless of the value of t, holding P_t constant.

Consequently, there are 13 parameters to estimate from equation (24): 12 values of A (one for each month), and 1 value for B. It is not possible to estimate these simultaneously, however, because the changes in expected price for each month are constant across years, leading to a singular matrix of independent variables in the estimating equation if dummy variables are included for the months. Instead, a two-step procedure is used. First, B is estimated holding A constant; second, the value of A is computed as detailed below.

The estimating equation for B uses data for the logarithm of private storage from July to March of 1979-87 as the dependent variable. April, May, and June are excluded because private storage for those months is more highly variable than for the other nine months, leading to heteroscedasticity. The higher variance in these months results primarily from differences in harvesting time across years and thus would cloud the analysis at hand. The independent variable is the expected price rise. This estimating equation produces an R^2 of 0.61 and a value for B of 0.255 with a t-statistic of 10.5.

Table 20 presents the second-stage, monthly values for the A parameter. These are computed by taking the residuals from the original estimating equation, averaging them for each month, then adding the result to the constant from the equation. The resulting parameters can be interpreted as the amount of storage that will take place each month if there is no expected change in price. Such figures are important, since some modeled policies hold prices close to constant throughout the year. One would expect the values of A to reach a peak in June or July and fall throughout the year until the next harvest begins in April. That general pattern holds, but as Table 20 shows, the estimates for October and November are smaller than the December figure. Consequently, in the policy exercise the constants are adjusted so that

$$A_{t+1} <= A_t \qquad \text{for } t < 10, \tag{26}$$

where $t = 1$ in May. Parameter A is allowed to increase in March and April, with the beginning of the harvest. The revised estimates, presented in column 2 of Table 20, are tested against the original estimates below.

Because a significant component of private storage is for own consumption, private storage is expected to increase with increases in the rural population, holding month and the expected price change constant. In order to test for the influence of rural population on private storage, a second-stage regression was run after adjusting the data series for the monthly values of the A parameter. The effect of this adjustment is to remove the variance in the dependent variable that is correlated with month but uncorrelated with the expected price changes. Consequently, this regression by design had to produce the same value for the B parameter as estimated above. The results are encouraging, with a reasonable elasticity of stocks to rural population of 1.1 and a t-statistic of 7.9. Consequently, the A parameters used in the model—column 3 of Table 20—include an adjustment for the size of the rural population.

Table 20—Parameters for monthly storage equations

Month	Estimated Series	Revised Series	Revised Series Adjusted for Rural Population
		(1,000 metric tons)	
May	2,570	2,570	2,905
June	4,674	4,674	5,283
July	3,549	3,549	4,012
August	4,566	3,549	4,012
September	2,049	2,049	2,316
October	1,325	2,034	2,300
November	1,540	3,034	2,300
December	2,034	2,034	2,300
January	1,930	1,930	2,182
February	1,252	1,252	1,415
March	1,570	1,570	1,775
April	1,920	1,920	2,170

Modeling Government Behavior and Costs

The government sector can be modeled in a straightforward manner. Government procurement and releases are assumed to be proportional to the difference between the actual price and the procurement or release price. Thus, the functional forms for equations (19) and (20) are

$$\begin{aligned} g_1(PP,P_t) &= G(PP - P_t) && \text{for } PP >= P_t && (27)\\ &= 0 && \text{for } PP < P_t, \end{aligned}$$

$$\begin{aligned} g_2(PR,P_t) &= G(P_t - PR) && \text{for } PR <= P_t && (28)\\ &= O_{min} && \text{for } PR > P_t. \end{aligned}$$

The G parameter measures the degree to which the government can defend its price ceiling and floor. It is taken to be 10 million, implying, for example, that procurement would be 2 million tons in a month when market prices are 20 paisa per 40 kilograms below the procurement price. As long as this parameter is large, it has no major effect on the results.

The minimum release parameter, O_{min}, is taken to be 160,000 tons. This equals the lowest figure for offtake per capita in any one month during the last 15 years, adjusted to 1987 population figures. This amount is assumed to be insensitive to price adjustments.

Government expenditure is computed as follows. The costs of buying are assumed to be Rs220 per ton. This includes the cost of bags, delivery charges, fumigation charges, transportation from procurement center to storage center, handling at the storage center, and part of the godown expenses and departmental charges. The costs of selling are assumed to be Rs280 per ton, which includes handling upon removal from storage and transport to the point of sale. Most of this amount is the cost of transporting to and marketing within farflung areas. These numbers are based on figures for incidentals reported by the Pakistan Agricultural Supply and Storage Corporation (PASSCO), the Punjab Food Department, and the Agroprogress and Indus (1986) study. For a more detailed breakdown of the method used to produce these numbers, see Appendix 4.

The government also incurs interest charges on its stock-on-hand of 1.2 percent per month. Physical losses to stock occur at the rate of 0.7 percent per month, or 3.5 percent for a five-month period. This figure is on the low side of studies of losses in government storage reported by Agroprogress and Indus (1986).

The final component of government cost is an adjustment for stock changes during the year. Choosing the appropriate price at which to value the stock is not straightforward, however. Since additional wheat cannot be bought or sold domestically without undermining the stated policy, prevailing domestic prices do not accurately reflect the value of the stock. Consequently, small changes in stock—less than 50,000 tons in a normal production year—are valued at a world price of US$110 per ton. Additions to stock greater than 50,000 tons are valued at the export parity price, since this implies a significant increase in stocks during a normal year. This price is taken here to be US$85 per ton. Similarly, deletions from stocks of more than 50,000 tons are valued at the import parity price of $150 per ton.

Validation of the Model

At this point a complete model of private storage behavior, government market intervention, and government cost structure has been specified. How closely does it model events of the last two years?

Since government policy did not change until March of 1987, present policy is irrelevant to the validation process. However, government offtake and procurement are known for each month during past years, so these figures are treated as exogenous and the model is solved for the endogenous variables: wholesale prices and private storage. Figures 13-16 in Appendix 5 compare the modeled results for endogenous private storage and prices to the historical values of private storage and prices, and to the results using the original A parameters rather than the adjusted A parameter series from Table 20. In each case the adjusted A parameter series is either as good as or superior to the original series. In comparison with the historical values, the fit is good for private storage and reasonably good for prices, considering that the model assumes that no new information enters the market during the year. The 1986/87 actual prices suggest that significant new information did become available between April/May and September/October. Perhaps the actual size of the crop was larger than had been anticipated at harvest time. In any event, the modeled pattern is reasonably good given the inherent instability in seasonal prices.

Results of the Model

The most important results of this model are presented in Table 21. These are discussed below. The first policy tested is the 1987/88 policy. With a crop of 13.4 million tons—an expected "normal" year for Pakistan—the policy of buying wheat at Rs2.00 per kilogram and selling it at Rs2.08 per kilogram is expected to cost Rs3.5 billion per year. Private storage at the end of July is 5.0 million tons. Total procurement under these circumstances is 4.9 million tons, an increase of more than 1.0 million tons compared with expected procurement under the previous policy. Prices reach their maximum in November and remain flat until a small decline in April. Thus there is a marked change in the seasonal price pattern.

Table 21—Implications of width of price band for fiscal cost and private storage

Procurement Price	Release Price	Difference	Fiscal Cost	Procurement	Private Storage, July	Private Storage, March	Difference
(Rs/kilogram)		(percent)	(Rs billion)		(million metric tons)		
2.00	2.00	0.0	5.4	7.1	4.2	1.7	2.4
2.00	2.05	2.5	3.9	5.3	4.8	1.5	3.3
2.00	2.08	4.0	3.5	4.9	5.0	1.4	3.7
2.00	2.10	5.0	3.2	4.7	5.2	1.3	3.9
2.00	2.15	7.5	2.6	4.1	5.6	1.0	4.5
2.00	2.20	10.0	2.0	3.6	5.9	0.8	5.0
2.00	2.25	12.5	1.6	3.2	6.1	0.7	5.5
2.00	2.30	15.0	1.3	2.8	6.4	0.6	5.8
2.00	2.40	20.0	0.8	2.2	6.8	0.4	6.4

Source: Author's calculations.

The Rs3.5 billion loss can be broken down into component parts as follows: physical storage losses of 220,000 tons, worth Rs0.6 billion (valued, as argued above, at import parity, since the policy as a whole sells more than it buys domestically); interest charges of Rs0.8 billion; costs of purchasing wheat of Rs1.1 billion; and costs of selling wheat of Rs1.4 billion. This last figure includes about Rs1.0 billion for distributing in the farflung areas, which is the cost of holding prices constant all over the country. The 8 paisa per kilogram difference between buying price and selling price brings the government Rs0.4 billion, thus yielding the Rs3.5 billion cost.

One policy under consideration at the time of derationing was to both buy and sell at Rs2.00 per kilogram. Had this policy been put into effect, the estimated annual cost would have been Rs5.4 billion per year, with procurement rising to 7.1 million tons and private storage in July falling to 4.2 million tons.

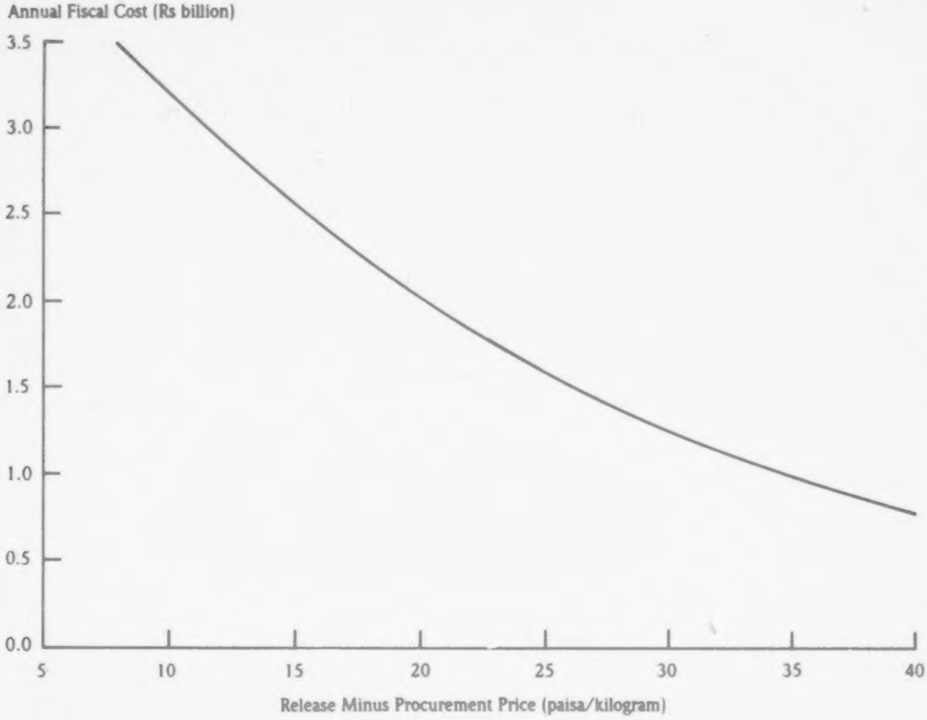
The cost savings that resulted from increasing the release price from Rs2.00 to Rs2.08 are much larger than those calculated from multiplying a single offtake figure by the 8 paisa per kilogram gap. With virtually no seasonal price rise, the private sector stores considerably less of the new crop. The increase in private storage from March to July (shown in the last column of Table 21) is more relevant in this context than the July storage figure alone. Because prices decline less in April and May under a flat price policy, private storage is actually *higher* in March and April under this policy, but absorbs considerably less of the harvest than under a policy in which prices are allowed to rise. Thus the government is hit with two large cost increases: the losses per kilogram handled increase because of the lower selling price, and the volume handled increases also. Consequently, losses increase dramatically.

Looked at the other way, losses decline dramatically with only small increases in the release price. Table 21 shows that a 2 paisa increase in the release price from Rs2.08 to Rs2.10 per kilogram is expected to save about Rs300 million per year. Allowing prices to rise 10 percent during the year—the result of making the release price 20 paisa above the procurement price—decreases losses to Rs2.0 billion per year, a savings of Rs1.5 billion annually. And allowing prices to rise 15 percent—a 30 paisa gap—saves Rs2.2 billion annually, with expected costs of Rs1.3 billion per year. As shown in Table 18 and Figure 9, this 15 percent price rise is less than the country has experienced historically.

Figure 11 presents the trade-off curve between price variability and fiscal cost. The horizontal axis is the percent difference between the procurement price and the release price, while the vertical axis is fiscal cost. Clearly there are large savings associated with the first percentage increments of the price differential. The savings that result from raising the gap further grow smaller as the gap grows larger.

The costs considered here are average annual operating costs. Additional savings would result from decreased storage requirements because of lower procurement. Construction costs are about Rs700 million for a million tons of storage (Experience, Zor, and Ferguson 1986). Thus, moving from the 1987/88 policy to one with a 30 paisa gap between procurement and release prices would also save about Rs1.5 billion in construction costs, since procurement declines by 2.1 million tons. This cost is a one-time savings, while the other costs mentioned above are annual savings. A loan for Rs1.5 billion at a 7 percent real interest rate would have an annual payment of about Rs120 million. In addition, 2.1 million tons of storage would have annual fixed costs for maintenance and operating expenses of Rs5-20 million annually. Thus, the total savings of moving from the 1987/88 policy to one with a 30 paisa gap expressed in annual terms would be about Rs2.4 billion annually.

Figure 11—Fiscal cost versus seasonal price band



Sensitivity Analysis

A sensitivity analysis is conducted here for three parameters. The first two parameters check for sensitivity to the specification of the demand equation. The model assumes that if the wholesale price is Rs84, 1 million tons of wheat will be consumed in a month. Values of 82 and 86 are tested here. Second, the own-price demand elasticity is tested. Based on Alderman (1988a), the own-price demand elasticity for wheat in Pakistan is about −0.7, according to the 1979 household and income expenditure survey. This is much larger in absolute value than is normally assumed for a staple food in a poor country. An even larger value of −0.9 is tested below to see if this extreme assumption affects results. Finally, parameter B, the private storage parameter, is tested for values of one standard error above and below its estimated value, taking the standard error from the first-stage estimating equation. Results are presented in Table 22.

The major conclusions do not change at all from these results. The chosen model estimates the cost of 1987/88 policy to be Rs3.47 billion per year and the cost of a policy including a 15 percent price rise to be Rs1.25 billion per year (Table 21, lines 3 and 8. For purposes of comparison, an additional significant digit is reported here.) The range reported in Table 22 is Rs3.40-3.54 billion for 1987/88 policy and Rs1.15-1.38 billion for a 15 percent price rise. The largest difference in estimated savings that result from increasing the width of the price differential to 15 percent is about Rs0.10 billion.

Table 22—Sensitivity analysis

Procurement Price	Release Price	Fiscal Cost	Procurement	Private Storage, July	Private Storage, March	Difference
(Rs/kilogram)		(Rs billion)	(million metric tons)			
Equilibrium Price = Rs82/40 Kilograms						
2.00	2.08	3.45	5.0	5.0	1.4	3.7
2.00	2.20	2.01	3.6	5.9	0.8	5.0
2.00	2.30	1.29	2.8	6.4	0.6	5.8
Equilibrium Price = Rs86/40 Kilograms						
2.00	2.08	3.49	4.9	5.1	1.4	3.7
2.00	2.20	2.04	3.6	5.9	0.8	5.0
2.00	2.30	1.24	2.8	6.4	0.6	5.8
Demand Elasticity = −0.9						
2.00	2.08	3.48	4.8	5.1	1.4	3.7
2.00	2.20	1.95	3.5	5.9	0.8	5.0
2.00	2.30	1.38	2.8	6.3	0.6	5.8
B Parameter 1 Standard Error Higher						
2.00	2.08	3.40	4.8	5.1	1.3	3.8
2.00	2.20	1.92	3.4	6.0	0.8	5.2
2.00	2.30	1.15	2.6	6.5	0.5	6.0
B Parameter 1 Standard Error Lower						
2.00	2.08	3.54	5.0	5.0	1.4	3.6
2.00	2.20	2.14	3.8	5.8	0.9	4.9
2.00	2.30	1.36	3.0	6.2	0.6	5.6

Source: Author's calculations.

Consequently, these results are considered to be robust. Actual costs in any particular year, however, could vary significantly from those reported here, especially because of deviations from normal production. In addition, the costs reported here are those associated with the policy after private stocks have adjusted to their new desirable level given the policy change. In the first years after a policy change, stock adjustments could significantly affect cost. Finally, as in any econometric exercise using estimated parameters, the further one moves from the policy under which the estimation took place, the less reliable are the results. Thus, results for price changes on the order of 10-20 percent should be considered more reliable than those with virtually no price change.

Conclusions

The benefits of raising the release price are clear. Savings of approximately Rs2 billion were realized from the government decision to release wheat at Rs2.08 per kilogram rather than Rs2.00 per kilogram. Significant additional reductions in cost will result from the wider band implemented for 1988/89.

The primary savings come from increasing private-sector storage. This study has only considered the benefits of increasing storage by increasing seasonal price changes, but there may be other ways the government could encourage such activity. Since more than 80 percent of private storage in July is on-farm, such storage has to be the primary focus of any such efforts. One obvious change would be to remove from the books the laws that allow the District Food Controller to force the sale of stocks of wheat to a specified agent at a specified price (Agroprogress and Indus 1986). Even if this power is not used, the presence of such laws on the books inhibits private storage.

The costs to the consumer of raising the release price are moderate. These can be estimated as in Chapter 4. If the government were to release wheat at Rs2.30 per kilogram, that price would be effective only during the months of December, January, and February according to the model, because private traders would undersell the government prior to December. Thus the average increase in wheat price would be only about 6.00 percent rather than the 11.00 percent increase from Rs2.08 to Rs2.30 per kilogram.[39] The average consumer spends about 8.00 percent of annual household income on wheat and wheat products. Thus, the real income loss associated with a 6.00 percent price rise is less than 0.50 percent. The poorest consumers, who spend about 12.00 percent of income on wheat and wheat products, would suffer an income loss for the year of less than 0.75 percent.

Nevertheless, the income loss is not spread out evenly over the months, and for the three months in which the maximum price is in effect the real income loss for the poorest consumers is (0.11 · 0.12) or 1.3 percent. If the income elasticity for calorie consumption is 0.5, this would imply a reduction in calorie consumption during those months of 0.6-0.7 percent, or about 15 calories per day. Although it is undesirable to reduce the income of the poorest group, it seems clear that a program that costs Rs2.3 billion annually to raise calorie consumption of the poorest groups by only 15 calories per day for only three months of the year is inefficient. Assuming that the poorest quartile of the population is the target group, the cost works out to approximately Rs1.00 for every 20 additional calories during the three high-priced months. Since Rs1.00 can buy about 1,500 calories, the inefficiency of the policy is obvious. The more efficient policy calls for government intervention in extreme circumstances, thus averting disastrous price rises, but allows for private marketing at most other times.

Another way to view the loss to consumers is to compare costs under a 15 percent change in official prices to those under the old system. As shown above, the average price rise under the old system was 15-20 percent, with some years substantially higher. Although the ration shop price was constant throughout the year, very little was actually being sold at the subsidized price (Alderman, Chaudhry, and Garcia 1988). Consequently, under a policy with a 15 percent price cap, the consumer would be no worse off than under the old system, and in some years substantially better off.

Thus, the model presented here allows for the measurement of trade-offs between cost and seasonal price stability. For the wider purposes of this study, the relationship between seasonal price policy and the demand for storage is important. Chapter 6 examines the final source of storage demand, import buffer stocks, and Chapter 7 aggregates the demand for storage from the three different sources.

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[39] The 6 percent figure is calculated by taking the average of the percentage increases by month as estimated by the model, weighting each month equally. Since one would expect higher consumption of wheat in low-price months, this estimate of the average price increase is on the high side. Graphs of single years of data in the Agroprogress and Indus (1986) report indicate that the price rise is similar for retail flour and wholesale wheat.

6

OTHER STORAGE REQUIREMENTS

Stocks for Smooth Functioning During Normal Periods

The third and final component of storage after interannual supply stabilization and seasonal stocks consists of amounts required to maintain the normal functioning of the market. This component can be broken down further into two subcomponents: the amount necessary during normal periods of operation, and the amount necessary to disburse after imports have been ordered but before they arrive in the country. This section estimates the former amount.

One way to approach this estimation is to examine past stock levels relative to offtakes. If no disruptions in supply occurred when stocks were at low levels, these historical amounts can be considered upper limits for the amount required to ensure normal operations. Because of the seasonal stocks the government has held in the past, the lowest stock levels have occurred at the beginning of April and May, immediately prior to the procurement season.

Stocks on May 1 have been less than offtake during May in 6 out of the last 18 years. Indeed, in May of 1970, 1972, 1974, 1975, and 1978, opening stocks were less than one-half of May offtake. In several of those years, the stocks held on April 1 were also less than offtake during April. Stocks have always been larger than offtake since 1978; nevertheless, the past history of lower stock levels indicates that if opening stocks are equal to expected offtakes in a given month, it is unlikely that supply disruptions will occur.

In planning for this component of storage, then, it is necessary to have an estimate of expected offtakes by month. The move away from the ration shop system has changed the nature of private-sector demand for government offtakes, thus past patterns may not be accurate indicators of the future. Nevertheless, in the last 10 years the ration shop system has moved away somewhat from a distribution of set quantities and toward meeting demand, at least partly because of the illegal diversion of supplies from the ration shops. Until more data become available on behavior since the policy change, these past patterns will be the most reliable indicators of the seasonality of demand for government supplies.

Since the pattern of offtakes took on a much more marked seasonal pattern after 1975/76, the period 1976/77-1986/87 will be considered. Past data are put in per capita terms to allow comparisons across years. Table 23 presents these offtake data for the individual months and averages over the time period. In addition, the standard deviation, maximum, and minimum are presented for each month. The last column presents aggregate data for the market year.

Over the 11 years in the table, offtakes per capita have averaged slightly over 36 kilograms per capita per year. There is no apparent trend in the data. The first seven months of the market year—May through November—all have averages under 3 kilograms, while December through April all have averages above 3 kilograms. Indeed, for the last four months of the market year, the minimum observed offtake per capita is greater than 3 kilograms. January, February, and March are the highest offtake months.

Table 23—Offtake per capita, by month, May 1976-April 1987

Scheme Year	May	June	July	August	September	October	November	December	January	February	March	April	Annual Total
							(kilograms)						
1976/77	2.55	2.46	2.25	2.60	2.14	2.27	2.64	3.14	3.87	4.65	4.72	4.00	37.3
1977/78	2.89	2.68	2.63	2.55	2.43	2.80	3.10	3.68	4.01	3.63	3.87	3.51	37.8
1978/79	2.93	2.89	2.94	3.05	2.71	3.03	2.97	3.40	3.58	3.51	3.60	3.33	37.9
1979/80	2.79	2.51	2.59	2.38	2.61	2.65	2.44	2.68	3.11	3.34	3.54	3.27	33.9
1980/81	2.70	2.55	2.47	2.23	2.37	2.34	2.71	2.98	3.28	3.18	3.24	3.14	33.2
1981/82	2.80	2.48	1.67	1.71	1.90	2.40	3.28	3.85	4.29	4.21	4.76	3.98	37.3
1982/83	2.64	1.93	1.63	2.05	2.23	2.72	3.06	3.51	3.91	3.74	3.88	3.80	35.1
1983/84	2.61	1.63	1.61	1.97	1.99	2.38	2.88	3.45	4.19	4.33	4.55	3.92	35.5
1984/85	2.01	1.85	2.44	2.60	2.84	3.03	3.25	3.88	4.66	4.18	4.53	3.90	39.2
1985/86	2.65	2.29	2.42	2.37	2.49	2.67	2.93	3.25	3.60	3.69	3.85	3.51	35.7
1986/87	3.01	2.34	2.49	2.46	2.56	2.65	2.76	3.10	3.49	3.44	4.27	3.84	36.4
Average	2.69	2.33	2.28	2.36	2.39	2.63	2.91	3.36	3.82	3.81	4.07	3.65	36.3
Standard deviation	0.26	0.36	0.43	0.35	0.28	0.25	0.25	0.35	0.44	0.45	0.50	0.30	1.73
Maximum	3.01	2.89	2.94	3.05	2.84	3.03	3.28	3.88	4.66	4.65	4.76	4.00	39.2
Minimum	2.01	1.63	1.61	1.71	1.90	2.27	2.44	2.68	3.11	3.18	3.24	3.14	33.2

Source: Collected from the Ministry of Food, Agriculture, and Cooperatives, data originate from the provincial food departments.

The highest offtake per capita in any one month occurred in March of 1982, 4.76 kilograms, while the lowest occurred in July of 1983, 1.61 kilograms.

Thus, it is clear that large numbers of persons rely on their own stocks or stocks from private traders during the first several months of the year, and then begin to depend on the government later in the year. Since average monthly per capita consumption is about 10 kilograms, the government is supplying about 40 percent of total consumption in March, but only about 20 percent in July.

The amount required for normal periods of operation, then, has a marked seasonal component. Multiplying the average per capita offtake figures by present population yields a requirement at the beginning of May of about 280,000 tons. For March, the figure is about 430,000 tons. As stated above, these should be considered upper limits, subject to change as more data become available from the postrationing era.

Import Buffer Stocks

Besides the stocks required for normal operations, there is a requirement for wheat to sell during the lag between ordering and receipt of imports. Normally it is assumed that imports take three months to arrive. This analysis will assume that four months are required from the time imports are ordered until that wheat is available for general distribution in the country.[40] Past patterns can also be useful here to examine how much government stocks have been depleted in any given four-month period.

The first step in the analysis is to take the data in Table 23 and aggregate it over four-month periods. This is done in Table 24, which presents four-month aggregates of per capita offtakes. In this case, the June-September period is the lowest offtake period at 9.36 kilograms per capita, while the January-April period is the highest at 15.35 kilograms. The maximum four-month offtake during the last 11 years was January-April 1985 at 17.27 kilograms per capita, and the minimum was June-September of 1983 at 7.21 kilograms.

Offtakes alone, however, overestimate the required import buffer stock. Even in a bad year, significant amounts are procured from surplus areas during April, May, June, and July. Table 25 adds procurement for the same four-month periods to the offtakes and presents the net offtake in each period.

Since procurement is considerably more variable than offtake, the standard deviations in Table 25 are much larger than those in Table 24. The maximum four-month period for net offtakes is December-March, with an average of 15.04 kilograms per capita, whereas the minimum is April-July at −21.89 kilograms per capita. April-July of 1986 had the lowest net offtake on the table at −39.01 kilograms, while December-March 1985 had the highest at 17.19.

It is of special interest that all of the numbers in Table 25 for March-June, April-July, and May-August are negative; moreover, in all the years after the 1978 rust attack, the smallest number (in absolute value) for these three periods is −11.71 kilograms per capita (for March-June of 1984). This implies that in all of these four-month periods, government stocks ended the period at higher levels than they began (ignoring any imports or exports that may have taken place). There is thus no need to order imports

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[40] In the rare case when a ship is delayed longer than this period of time, it is possible in the international wheat market to pay a premium in order to divert a ship bound for another port to Karachi. Such occurrences should be infrequent enough that this excess cost can be ignored.

Table 24—Cumulative per capita offtakes: four-month aggregates, 1976/77-1986/87

Scheme Year	May-August	June-September	July-October	August-November	September-December	October-January	November-February	December-March	January-April	February-May	March-June	April-July
							(kilograms)					
1976/77	9.85	9.44	9.25	9.65	10.19	11.92	14.30	16.37	17.24	16.26	14.29	12.20
1977/78	10.75	10.29	10.41	10.88	12.01	13.59	14.42	15.19	15.03	13.95	13.21	12.27
1978/79	11.81	11.59	11.72	11.76	12.11	12.98	13.46	14.08	14.01	13.22	12.22	11.21
1979/80	10.26	10.09	10.23	10.08	10.38	10.88	11.57	12.67	13.26	12.85	12.06	10.99
1980/81	9.95	9.63	9.42	9.66	10.40	11.31	12.14	12.67	12.83	12.35	11.66	10.08
1981/82	8.65	7.76	7.68	9.29	11.43	13.82	15.63	17.11	17.25	15.59	13.32	10.19
1982/83	8.25	7.84	8.63	10.05	11.52	13.20	14.22	15.04	15.33	14.03	11.92	9.65
1983/84	7.83	7.21	7.96	9.22	10.69	12.90	14.85	16.52	16.99	14.81	12.33	10.21
1984/85	8.89	9.73	10.91	11.72	13.00	14.82	15.97	17.25	17.27	15.27	13.38	11.27
1985/86	9.74	9.58	9.96	10.47	11.35	12.46	13.48	14.40	14.65	14.06	12.71	11.35
1986/87	10.30	9.85	10.16	10.43	11.07	12.00	12.78	14.30	15.03	13.99	13.44	11.94
Average	9.66	9.36	9.67	10.29	11.29	12.72	13.89	15.05	15.35	14.21	12.77	11.03
Standard deviation	1.11	1.22	1.17	0.83	0.82	1.10	1.31	1.54	1.56	1.13	0.77	0.86
Maximum	11.81	11.59	11.72	11.76	13.00	14.82	15.97	17.25	17.27	16.26	14.29	12.27
Minimum	7.83	7.21	7.68	9.22	10.19	10.88	11.57	12.67	12.83	12.35	11.66	9.65

Source: Collected from the Ministry of Food, Agriculture, and Cooperatives, data originate from the provincial food departments.

Table 25—Cumulative per capita net offtakes: four-month aggregates, 1976/77-1986/87

Scheme Year	May-August	June-September	July-October	August-November	September-December	October-January	November-February	December-March	January-April	February-May	March-June	April-July
						(kilograms)						
1976/77	-19.41	-11.32	1.36	7.42	9.02	11.29	14.04	16.35	16.85	8.08	-4.72	-10.51
1977/78	-12.70	-5.86	4.95	9.12	11.37	13.44	14.42	15.19	14.55	5.61	-0.20	-1.58
1978/79	-1.68	5.93	11.11	11.59	12.06	12.95	13.46	14.08	13.46	0.16	-12.69	-17.13
1979/80	-18.20	-6.53	5.41	8.69	9.67	10.83	11.57	12.67	12.40	-6.38	-21.01	-24.16
1980/81	-24.80	-7.00	6.59	8.91	10.13	11.28	12.14	12.67	10.94	-13.30	-31.50	-35.93
1981/82	-36.18	-13.57	3.84	8.30	11.14	13.78	15.60	17.09	16.12	4.29	-16.64	-24.87
1982/83	-26.31	-16.63	2.81	9.34	11.44	13.20	14.22	15.04	14.22	-4.31	-25.77	-31.65
1983/84	-33.15	-16.81	3.28	8.16	10.43	12.89	14.85	16.52	15.86	-5.15	-11.71	-14.18
1984/85	-14.46	5.19	10.46	11.63	13.00	14.82	15.97	17.19	13.75	-8.02	-12.48	-15.10
1985/86	-13.21	6.40	9.34	10.42	11.35	12.46	13.48	14.32	11.71	-18.80	-34.26	-39.01
1986/87	-37.71	-8.28	6.15	9.88	11.04	12.00	12.78	14.28	11.81	-10.00	-23.53	-26.68
Average	-21.62	-6.23	5.94	9.40	10.97	12.63	13.87	15.04	13.79	-4.35	-17.68	-21.89
Standard deviation	10.67	8.22	3.06	1.30	1.06	1.15	1.30	1.54	1.86	7.91	10.18	10.84
Maximum	-1.68	6.40	11.11	11.63	13.00	14.82	15.97	17.19	16.85	8.08	-0.20	-1.58
Minimum	-37.71	-16.81	1.36	7.42	9.02	10.83	11.57	12.67	10.94	-18.80	-34.26	-39.01

Source: Collected from the Ministry of Food, Agriculture, and Cooperatives, data originate from the provincial food departments.

between March and June; by the time the imports arrived, government stocks would be higher than when they were ordered.

The import buffer component of government stocks for February, March, and April, therefore, simply needs to be enough to bridge the gap until procurement comes on line at the end of the market year. From June to January, however, there is a need for stocks in case imports are required. These needs should be based on the highest observed offtake per capita over each four-month period, since offtakes are likely to be on the higher end of the scale in deficit years.

Therefore, month-by-month storage requirements for these two components are as reported in Table 26. The absolute amounts are computed by multiplying the per capita figures by 105 million persons. The monthly required stock—column 5 of the table—is the larger of either the import buffer or the amount required for normal operations, since the import buffer stocks can also fulfill the normal operations role. The import buffer is the larger of the two in all months except May.

The monthly required stock shown in column 5, then, is the minimum amount of wheat with which the government should begin any month. If opening stocks for any month are below the amount shown in this column, imports should be ordered if there is enough time for them to arrive before procurement begins. During March and April and to some extent in February, it is unlikely that imports could be ordered, received, and distributed before the country is again in surplus. Consequently, for these months the numbers are reference points that can be used as targets in earlier months rather than import triggers.

The required stocks peak in December and drop off only slightly in January. It is clear that if the January requirement is going to be met without imports, then all previous targets will be met also. The subsequent targets will be met, too, unless offtakes per capita increase to levels above the historical maximum. Based on this observation, the last column in Table 26 shows the amount of stock required at the beginning of each month to ensure that the January target is met if net offtakes per capita follow the average historical pattern. For January and subsequent months, the column is equal to the required stock column. The export trigger column peaks in

Table 26—Storage requirements for normal operations and import buffer

Month	Import Buffer		Normal Operations		Monthly Required Stock	Minimum Amount to Trigger Exports
	Per Capita	Absolute	Per Capita	Absolute		
	(kilograms)	(1,000 metric tons)	(kilograms)	(1,000 metric tons)	(1,000 metric tons)	
May	0.0	0	2.69	282	282	650
June	6.4	672	2.33	245	672	2,040
July	11.1	1,167	2.28	239	1,167	3,047
August	11.6	1,221	2.36	248	1,221	3,108
September	13.0	1,365	2.39	251	1,365	2,920
October	14.8	1,556	2.63	276	1,556	2,694
November	16.0	1,677	2.91	306	1,677	2,424
December	17.2	1,805	3.36	353	1,805	2,121
January	16.9	1,769	3.82	401	1,769	1,769
February	13.4	1,404	3.81	400	1,404	1,404
March	8.7	918	4.07	427	918	918
April	4.0	420	3.65	383	420	420

Source: Author's calculations.

August at 3.1 million tons. If early August stocks are above this amount and world prices are such that interannual supply stabilization stocks are uncalled for, the amount in excess of 3.1 million could be exported without fear that imports would be required during the present market year. These numbers, then, are the minimum figures that the government would want to use as export triggers.

This last column in the table also provides the maximum storage space requirement for these components. If the government had only enough space for the monthly required stock, it could not store sufficient quantities from the previous harvest to meet the required stock amounts for January. Thus, storage requirements to ensure normal operations must be at least 3.1 million tons, with the amount peaking in early August.

These calculations are based on past data, with some weight placed on the highest historical observations of offtake per capita. Actual requirements for monthly offtake will depend to a significant extent on the gap between the procurement and release price, discussed in Chapter 5. In particular, should the government increase the gap significantly, private stocks may play a more important role, and thus stocks required for import buffer and normal operations may decrease. In addition, during the years when these past data were produced, the government was not promising to sell all that was demanded at a set price. If the government convinces private agents that it will sell whatever is demanded and arrange for imports in a timely manner when necessary, speculative runs will be avoided. Since there was no maximum price under the old system, there was more incentive to hoard grain during a time of perceived scarcity. Thus, per capita offtake, and consequently stock requirements, during the deficit years in Table 25 should be an upper limit to net demand for government stocks under present policy.

In sum, the demand for stocks to maintain the normal functioning of the market is highly seasonal. Amounts required to buffer import arrival are the most seasonal, but requirements for normal operations also have a significant seasonal component. Total storage requirements can only be estimated on a monthly basis because of this highly seasonal nature. The maximum required storage capacity in any one month for the components measured in this chapter is 3.1 million tons; this estimate, which is based on historical data, is thought to be on the high side given recent policy changes.

7

CONCLUSIONS

Total Requirement for Government Storage Facilities

Previous chapters have measured the requirements for government storage from the three different sources: interannual supply stabilization stocks, seasonal storage, and stocks to ensure a continuous supply of wheat under all circumstances. This chapter combines the results from the different analyses in order to calculate the total demand for public storage of wheat. Interannual supply stabilization stocks do not appear in this analysis, since Chapter 4 shows that it is unprofitable to build additional capacity for such stocks.

Government storage capacity will be equal to required size of stock in the highest demand month in a year of abundant supply. Thus, in order to estimate total demand for public storage, it is necessary to compare demand for storage space for procurement in a high-production year with the monthly stock requirements for normal operations, import buffer, and minimum export trigger from Table 26. Clearly, if the demand for space for procurement is above the highest value of the minimum export trigger, required storage capacity for the export trigger will be satisfied if sufficient space for procurement is available.

Before such a comparison is made, however, it is necessary to translate the annual procurement figures from Chapter 5 into monthly requirements for storage space. To accomplish this, the percentage of total procurement that took place in each month is calculated for buying years 1984-87. The chosen starting year is 1984 because the procurement season apparently shifted to somewhat earlier dates beginning with that year. Ignoring the small amounts of procurement in March, August, and September, the percentage of procurement that has taken place in April, May, June, and July is approximately 8, 63, 24, and 5 percent, respectively.

Expected procurement in April is less than expected offtake. Therefore, the opening stocks in May assumed in the calculation of the procurement storage requirement is the minimum export trigger for May from Table 26, 650,000 tons. If opening stocks are larger than this amount and the crop is abundant, exports can be arranged immediately. Total requirements for May are therefore 650,000 tons plus 63 percent of procurement less expected offtake in May. The June requirement replaces the 650,000-ton opening stock with the calculated figure for closing stocks in May.

Total annual procurement must also be assumed in order to calculate specific storage requirements. As shown in previous chapters, procurement will vary with both crop size and the gap between procurement and release prices. Procurement in a normal production year for any given gap between procurement and release prices is presented in Table 21. Since this analysis is for maximum public storage requirements under a particular price policy, however, these levels of procurement must be adjusted upward for good crop years.

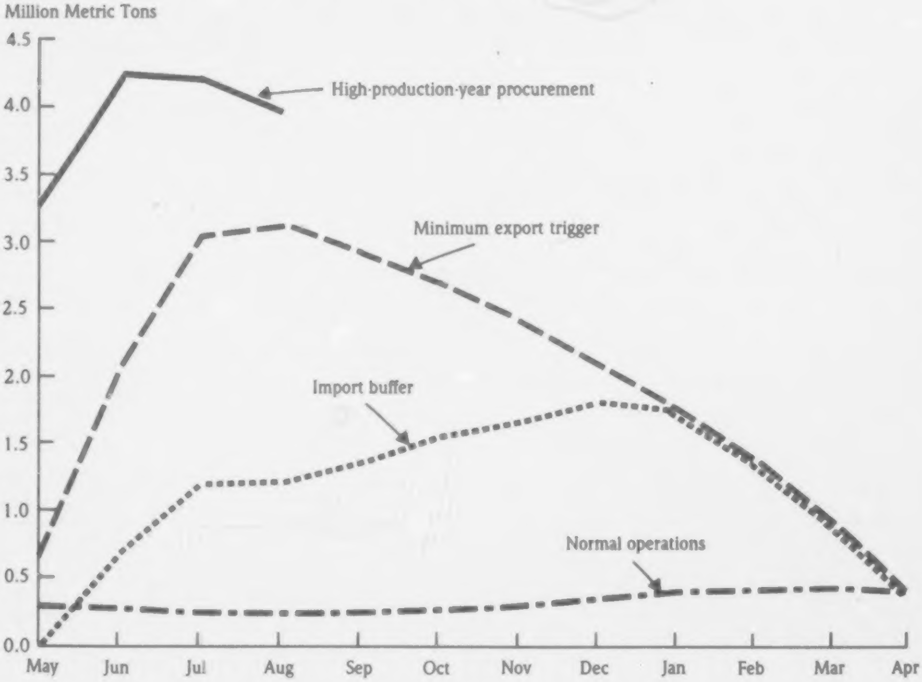
These adjustments can be made in the following manner. Elsewhere it has been estimated that an increase in production of 100,000 tons leads to an increase in procurement of about 84,000 tons (Pinckney 1988c). The percentage is much higher than the average share of production procured—about 30 percent—because two factors are working together. First, virtually all of the increase in production in an exceptionally good year is marketed surplus, while a large percentage of a normal crop is consumed on-farm. Second, the increase in marketed surplus leads to a decline in the wholesale price, causing procurement to consume a larger percentage of marketed surplus.

The 84 percent marginal rate can be applied to the expected increase in production in a good year. Clearly the size of the increase depends on how unusual the year is. With a standard deviation of production of 6 percent (see Chapter 3), a crop 10 percent above trend would be expected to occur only once every 20 years. Ten percent of the 1987/88 normal year production level is about 1.3 million tons; 84 percent of that amount is about 1.1 million tons. Thus, a figure of 1.1 million tons needs to be added to the normal production year procurement in order to account for demand for storage from procurement in an exceptionally good year.

Therefore, with a 20 paisa gap between the procurement and release prices, total procurement in an exceptional year would be 3.6 + 1.1 = 4.7 million tons. This total annual procurement is apportioned by month and adjusted for offtakes in Figure 12. Calculations are made below both for a gap of 8 paisa—the 1986/87 gap—and for a gap of 30 paisa or 15 percent—the approximate historical seasonal price rise.

Although total procurement is 4.7 million tons, total storage requirements never reach this level because of offtakes during the buying season. The curve for the storage of high-production-year procurement peaks in June and July at 4.2 million tons. As this amount is above the 3.1-million-ton peak of the minimum export trigger line, there

Figure 12—Total storage requirements: 20 paisa seasonal gap



would always be sufficient capacity for normal operations and import buffer if there is sufficient capacity for high-production-year procurement. Therefore, 4.2 million tons would be the required storage capacity of the government for wheat if the gap between the procurement and release prices is 20 paisa.

As pointed out in Chapter 5, however, the appropriate storage capacity of the government is a function of price policy. If the government were to institute a gap of 30 paisa per kilogram between the procurement and release prices, expected procurement in an excellent production year would be 3.9 million tons. Under this scenario, requirements peak in June at 3.5 million tons, or 700,000 tons below requirements when the price gap is 20 paisa per kilogram. This is still above the 3.1 million minimum export trigger. Similarly, if the policy for 1987/88 had been continued so that there was only an 8 paisa gap, expected procurement after a bumper crop would be 6.0 million tons, with peak requirements of 5.4 million tons in July.

Thus, government storage requirements for wheat at present are 3.5-5.4 million tons, assuming that the gap between procurement and release prices is between 8 and 30 paisa per kilogram. The projections in Chapter 3 suggest that wheat production will increase at a rate of approximately 3.3 percent annually. This implies that required storage capacity of the government will have to rise to between 5.3 and 8.2 million tons by the year 2000, with the exact point determined by price policy.

Policy Implications

Policy changes implied by this analysis have been discussed throughout the report. These include

- Choosing a gap between procurement and release price that takes account of the large cost savings both from lower annual subsidies and reduced future storage requirements;
- Allowing the official domestic price to respond to changes in production by introducing a production bonus system after choosing an appropriate level of variability of interannual domestic prices;
- Holding no interannual supply stabilization stocks; and
- Allowing the domestic price to reflect changes in the world price.

The most important of these policy adjustments is the gap between the procurement and release prices. Chapter 5 shows that a 2 paisa increase in this gap from its 1987/88 level saves Rs300 million annually (about US$17 million), with cost savings for reduced storage requirements above this amount. Over a wider range, this tool has the potential to save the government billions of rupees annually.

If the gap between the procurement and release prices remains smaller than government marketing costs, the second intervention to consider is introducing the production bonus payment system as outlined in Chapter 4. The key to having an efficient interannual supply stabilization policy is allowing average domestic prices to vary somewhat from year to year, depending on the crop size and the government's desired trade-off between price variability and fiscal cost. The average annual price will change very little as long as the gap is less than marketing costs. Introducing a production bonus payment—even a very small one—could decrease costs by about 100 million rupees annually.

Of equal importance to introducing a production bonus payment is lowering interannual supply stabilization stocks to zero unless the world price plummets to unprecedented depths. This change also saves about 100 million rupees annually, depending on the exact level of stock reduction. If the government is to lower interannual supply stabilization stocks to zero, however, it is necessary to ensure the availability of foreign exchange for imports when supplies are short. This should not be a problem, as the analysis clearly shows that the average supply of foreign exchange is higher under a policy with low stocks than under one with large stocks. Nevertheless, there are individual years when large imports will be necessary. The IMF Compensatory Financing Facility, discussed in Appendix 6, is one possible source of foreign exchange in such years.

The next most important policy adjustment would be to allow official prices to reflect changes in the world price between September and April by instituting a world price bonus payment system. This would save about Rs 30 million annually, depending on the overall degree of price variability.

The final policy change suggested here is to change the law concerning the ability of government agents to seize private stores in an emergency. The payoff from this change is unmeasurable, but any increase in other incentives will decrease the seasonal price increase required to induce the private sector to store a given amount of grain, and will thus lower the cost to the government of any particular seasonal price policy. Given the high responsiveness of fiscal cost to the size of the gap, the payoff from a policy change such as this is likely to be large.

Thus, the policy adjustments considered here all move toward making Pakistan's wheat policy more sensitive to uncontrollable parameters, such as weather-induced fluctuations in crop size and changes in the world price. The most efficient way to create this sensitivity is to encourage more private-sector involvement in seasonal storage by increasing the price incentive and removing the legal disincentive, and to implement some sensitivity of official prices to outside forces. Interannual government stocks are an inefficient way to stabilize supplies.

In the interannual context, however, it is very important that the government actually sell all that is demanded at its ceiling price, whatever that price may be. As long as private agents expect the government to defend its price, there is no incentive to attempt to hoard, since there will be no returns to hoarding. On the other hand, if private agents sense that the government is holding back on supplies, there could be a costly run on government stocks. Even in this situation—rather, especially in this situation—it is vital that the government sell sufficient quantities to meet demand, importing all that is necessary to do so. In the long run, consistency in meeting demand will be cheaper than restricting supplies because of the expectations formed that the government will always defend its price.[41]

Thus, if the government is concerned about lowering fiscal cost, ensuring supplies for the market, and allowing the growth of private marketing activities, increasing the gap between the procurement price and the release price should be the first priority. Next, lowering interannual supply stabilization stocks and introducing some response of official prices to production size should be considered. Adding sensitivity to the world price would lower costs further. Finally, removing the legal impediments to private storage would have an unmeasurable benefit that could be large.

Implications for Other Countries

Pakistan presents a particularly interesting case for analyzing the demand for storage because of the recent change in marketing policy there. Some conclusions—such as the inefficiency of building any additional storage for supply stabilization stocks and the relative benefits of different policy modifications—will not carry over to other countries. The general pattern of policy changes that will lead to more efficient price, storage, and trade policies, however, will be similar for other countries that are normally self-sufficient in a staple food.

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[41] See Siamwalla 1988 for a discussion of the importance of this factor in the success of Indonesia's storage, trade, and price policy for rice.

The need to analyze separately the three components of storage demand has been brought out clearly. Although interannual stocks should be zero for Pakistan at present world prices, some countries should hold stocks across years when surpluses exist. The following changes in parameters will increase the average size of efficient interannual stocks.

1. Higher production variability. As noted in Chapter 3, Pakistan's production variability for its staple food is one of the lowest in the world. Larger fluctuations in domestic availability shorten the expected length of time that the government will have to hold a given quantity of stock, thereby lowering expected holding costs and leading to higher levels of interannual storage.

2. Higher transaction costs for foreign trade. Although the costs of engaging in foreign trade are quite high for Pakistan, costs for many less developed countries, particularly those in Africa, are higher. Higher transaction costs lower the cost of storage relative to the cost of international trade, leading to higher interannual storage.

3. A preference for the domestic staple. In Pakistan there is no consumer preference for domestically produced wheat over imported wheat. White maize consumers, on the other hand, typically have a strong preference for white maize over the yellow maize that dominates international trade. Strong preferences of this type add a third element to the government objective function, a desire to limit imports even when there are no fiscal losses from importing and selling domestically. This provides further incentive for storing excess domestic production across years.

4. A lower own-price elasticity of demand. This parameter for Pakistan was assumed to be quite low at –0.3. Nevertheless, a lower elasticity would decrease the extent to which consumption adjusts when prices change, thus forcing trade and stock changes to absorb more of the production variability.

When several of these parameters change in the same direction, the size of efficient interannual storage could be large. Thus, it would be inappropriate to claim that most countries should avoid holding interannual supply stabilization stocks altogether. The techniques for efficiently stabilizing prices, however, should carry over to other countries. For example, the sensitivity of the domestic price to domestic production and the world price that results from instituting a production or world price bonus payment system usually will result in some gain in efficiency. It is always more costly to stabilize prices completely than to allow some variability. In general, the cost of stabilizing prices increases as complete stability is reached. Since the marginal benefits of stability are in essence politically determined, economists alone are unable to equate marginal benefits with marginal costs. But the measurement of trade-offs between objectives as performed in Chapter 4 is useful for helping to determine the appropriate degree of price variability. As long as the political cost of a 1 percent change in official prices is not infinite, there is some scope for price adjustments.

Although several suggestions have been made here for improving interannual price and storage policy, most governments that are involved in storage operations will discover that the largest single element of storage demand and the largest potential cost-savings are in seasonal rather than interannual policy. This flows mainly from the much greater potential for public displacement of private storage in the seasonal case.

Even in this area, however, the benefits of increasing the gap between government buying and selling prices may be considerably less in other countries. One of the driving forces behind the results for Pakistan is the large loss associated with each ton of wheat handled under present policy. A decrease in the gap increases losses per unit handled *and* increases the volume handled, leading to a large increase in losses. For countries in which the difference between buying and selling prices approximates government costs, the benefits of increasing the gap will be small.

In conclusion, this study has highlighted the three different components of the demand for government storage, which are often confused. In conducting a separate analysis of each of the components, frequently the neglected seasonal component will be the most important. For many countries, the efficient size of interannual supply stabilization stocks may be quite small except in periods of unusually low world prices. A monthly analysis of import buffer stocks is useful for estimating the minimum size of export triggers. These three components constitute the demand for public storage.

APPENDIX 1: SUPPLEMENTARY TABLES

Table 27—Area equation results, by agroclimatic zone

Coefficient	Rice/Wheat Punjab	Mixed Punjab	Cotton/ Wheat Punjab	Low-Intensity Punjab	*Barani* Punjab	Rice/Other Sind	Cotton/ Wheat Sind	Other NWFP[a]	Other Baluchistan
Constant	590	252	171	249	233	25.7	79.5	186	20.1
Lagged area, wheat	0.343 (2.25)	0.821 (7.87)	0.699 (5.7)	0.498 (2.04)	0.329 (1.68)	0.381 (2.5)	−0.0263 (−0.11)	0.471 (2.32)	0.230 (1.03)
Expected revenue, wheat	13.58 (2.94)	1.43 (0.432)	1.64 (0.205)	6.71 (1.67)	. . .	. . .	−0.906 (−0.32)	8.47 (1.95)	3.33 (2.35)
Procurement price, wheat	. . .	. . .	. . .	. . .	6.80 (2.78)	−0.432 (−0.08)	. . .	. . .	. . .
Cotton price	. . .	. . .	0.184 (0.33)	. . .	. . .	. . .	. . .	. . .	. . .
Expected revenue, cotton	. . .	. . .	. . .	. . .	. . .	. . .	0.904 (0.62)	. . .	. . .
IRRI rice price	. . .	. . .	. . .	. . .	. . .	3.63 (1.09)	. . .	. . .	. . .
Basmati rice	−3.54 (−1.41)	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Urea price	. . .	−0.175 (−2.07)	−0.145 (−0.86)	−0.146 (−0.97)	. . .	−0.0598 (−0.83)	−0.149 (−1.35)	. . .	0.0609 (0.85)
Rainfall, October	. . .	. . .	. . .	. . .	0.323 (1.51)	2.38 (2.76)	. . .	. . .	. . .
Rainfall, November	. . .	1.06 (2.15)	. . .	. . .	0.578 (2.53)	. . .	. . .	. . .	. . .
Rainfall, October/November	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.519 (1.21)	. . .
Rainfall, November/ December	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1.19 (3.09)
Expected water availability	. . .	. . .	2.12 (2.13)	2.62 (1.14)	. . .	. . .	8.37 (4.06)	. . .	. . .
Surface water availability, rabi season	. . .	. . .	. . .	. . .	. . .	21.27 (2.63)	. . .	. . .	. . .

Table 27—Continued

Tubewells	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.00236 (0.3)	. . .
R^2	0.82	0.85	0.94	0.85	0.59	0.79	0.95	0.88	0.52
Adjusted R^2	0.78	0.81	0.92	0.81	0.46	0.68	0.92	0.85	0.37
Standard error	33.40	26.00	50.00	32.00	12.70	21.30	25.50	26.50	21.80
h-statistic	−0.80	−0.95	−0.32	[b]	1.10	0.25	[b]	1.13	0.25

Notes: t-statistics are in parentheses.

Rainfall series for each zone were computed by averaging rainfall stations within each district and then computing a weighted average of the district rainfall by month for each zone, with the weights equal to the share of each district in zonal production.

The series for surface water availability has been created by the author by apportioning the water flowing through individual canals to zones based on the proportion of the canal in each zone. Total water availability adds to the surface water an amount from tubewells, computed by multiplying the number of tubewells in each zone by a standard withdrawal. Expected water availability was constructed from the water availability series by computing a series of five-year trends and projecting those trends one year forward.

The tubewell series for the Other NWFP zone is a constant proportion of the provincial series.

[a] North-West Frontier Province.

[b] h-statistic cannot be computed. Durbin-Watson statistic is 2.09.

Table 28—Yield equation results, by agroclimatic zone

Coefficient	Rice/Wheat Punjab	Mixed Punjab	Cotton/ Wheat Punjab	Low-Intensity Punjab	*Barani* Punjab	Rice/Other Sind	Cotton/ Wheat Sind	Other NWFP[a]	Other Baluchistan
Constant	−0.0242	0.597	0.878	0.230	0.151	−0.285	1.09	0.176	0.0397
Procurement price	0.0420 (1.52)	0.0461 (2.26)	0.0305 (2.05)	0.0420 (1.71)	0.00625 (3.63)	0.0324 (1.25)	−0.00717 (−0.4)	0.0192 (1.14)	0.00400 (0.17)
Fertilizer sales	0.00293 (1.83)	0.00311 (7.04)	0.000877 (3.54)	0.00271 (1.40)	0.02 (3.18)	. . .	. . .	0.00449 (2.56)	. . .
High temperature	−0.0113 (−0.44)	. . .	−0.0138 (−1.59)	. . .	. . .	−0.0103 (−0.58)	. . .	. . .	. . .
Water availability, *rabi* season	0.00560 (0.88)	. . .	0.00339 (3.04)	0.00511 (0.95)	. . .	. . .	. . .	. . .	. . .
Rainfall, December	. . .	. . .	−0.00166 (−1.74)	−0.00358 (−1.95)	. . .	. . .	. . .	. . .	. . .
Cotton price	. . .	. . .	−0.00196 (−2.04)	. . .	. . .	. . .	−0.00118 (−1.47)	. . .	. . .
Temperature	. . .	. . .	. . .	−0.0464 (−1.61)	−0.0316 (−1.9)	. . .	. . .	. . .	. . .
Rainfall, November	. . .	. . .	. . .	. . .	0.00310 (3.30)	. . .	. . .	. . .	. . .
Rainfall, December-February	. . .	. . .	. . .	. . .	0.000733 (3.69)	. . .	. . .	. . .	. . .
Square root of tubewells	. . .	. . .	. . .	. . .	. . .	0.00643 (6.63)	0.0100 (16.4)	. . .	. . .
Surface water availability, rabi season	. . .	. . .	. . .	. . .	. . .	0.076 (1.87)	. . .	. . .	. . .
Urea price	. . .	. . .	. . .	. . .	. . .	. . .	−0.000102 (−0.46)	. . .	. . .
Tubewells	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.00007 (4.1)	0.000131 (3.4)
Rainfall, annual	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.000134 (0.58)	0.000982 (1.09)

Table 28—Continued

R^2	0.82	0.78	0.89	0.68	0.98	0.90	0.98	0.92	0.88
Adjusted R^2	0.77	0.75	0.84	0.54	0.97	0.86	0.97	0.90	0.84
Standard error	0.1200	0.0826	0.0595	0.1000	0.0438	0.1030	0.0640	0.0663	0.1180
Durbin-Watson	1.99	2.52	2.96	1.58	2.01	1.48	1.98	1.62	0.83

Notes: t-statistics are in parentheses.

"High temperature" was computed as an average of the five highest daily highs during a critical 15-day period. The critical period was February 5-20 for Hyderabad and was progressively later for more northern zones. If the average on the five highest days was less than a given critical value, the value of the variable was zero. Otherwise, the value was the average of those five days minus the critical value. The "Temperature" variable is constructed similarly, but uses the average high for March.

The series for surface water availability have been created by the author by apportioning the water flowing through individual canals to zones based on the proportion of the canal in each zone. Total water availability adds to the surface water an amount from tubewells, computed by multiplying the number of tubewells in each zone by a standard withdrawal.

Rainfall series for each zone were computed by averaging rainfall stations within each district and then computing a weighted average of the district rainfall by month for each zone, with the weights equal to the share of each district in zonal production.

The tubewell series for Punjab zones aggregate district data. For Sind, NWFP, and Baluchistan, no district data are available, so the zonal series are constant proportions of provincial data.

[a] North-West Frontier Province.

Table 29—Key parameter values of the interannual models

Parameter	External	Internal
Transactions costs of importing	US$30	Rs170[a]
Transactions costs of exporting	US$-13[b]	Rs646
Shadow price premium on foreign exchange	. . .	10 percent
Discount rate	7 percent	7 percent
Mean production	. . .	13 million metric tons
Coefficient of variation of production	. . .	6 percent
Normal-production-year equilibrium price (rupees per 40 kilograms)	. . .	Rs85
Annual cost of storage per metric ton	. . .	Rs425
Opening world price	US$110	. . .
Standard deviation of world price	US$20	. . .
Own-price demand elasticity	. . .	−0.3

Note: Food aid equals 50 percent of the shortfall in total supply below 12.5 million metric tons, where total supply equals production plus opening government stocks.

[a] For the sake of simplicity, government handling costs of domestic wheat are not explicitly modeled. This allows for the separation conceptually of the costs of subsidies on wheat consumption from the costs of interannual supply stabilization. In the model, this is accomplished by not including a charge for government handling of wheat, and by having the selling price equal the buying price. This necessitates the excess charge for domestic handling of imported wheat over and above the charges on domestically produced wheat.

[b] Lower international transactions for Pakistani wheat as opposed to those for U.S. wheat.

APPENDIX 2: CHOOSING BETWEEN LINEAR AND EXPONENTIAL TRENDS

The following selection procedure was used for selecting between linear and exponential trends:

1. Estimate:

$$\mathbf{Y} = a_1 + b_1\mathbf{T} + \mathbf{e}_1,$$

where **Y** is the dependent vector, **T** is the time vector, and $\mathbf{e}_1$ is the vector of residuals of the linear trend.

2. Estimate:

$$\log\mathbf{Y} = a_2 + b_2\mathbf{T} + \mathbf{u}_1,$$

where $\mathbf{u}_1$ is the vector of residuals of the exponential trend.

3. Compute the residuals of the transformed fitted values for both equations:

$$\begin{aligned} \mathbf{e}_2 &= \log\mathbf{Y} - \log(a_1 + b_1\mathbf{T}), \\ \mathbf{u}_2 &= \mathbf{Y} - \exp(a_2 + b_2\mathbf{T}), \end{aligned}$$

where exp( ) is the exponential function (taking antilogs).

The linear equation is the better fit if the sum of squared residuals of the linear equation is less than the sum of squared residuals of the log-linear equation in both linear and logarithmic space:

$$\mathbf{e}_2'\mathbf{e}_2 < \mathbf{u}_1'\mathbf{u}_1 \text{ and } \mathbf{e}_1'\mathbf{e}_1 < \mathbf{u}_2'\mathbf{u}_2.$$

The exponential equation is the better fit if

$$\mathbf{u}_2'\mathbf{u}_2 < \mathbf{e}_1'\mathbf{e}_1 \text{ and } \mathbf{u}_1'\mathbf{u}_1 < \mathbf{e}_2'\mathbf{e}_2.$$

Otherwise, the problem is indeterminate. In this case, we chose the exponential trend if

$$\mathbf{u}_2'\mathbf{u}_2/\mathbf{e}_1'\mathbf{e}_1 < \mathbf{e}_2'\mathbf{e}_2/\mathbf{u}_1'\mathbf{u}_1.$$

APPENDIX 3: EQUATIONS FOR INTERANNUAL OPTIMIZATION PROBLEM

The structure of the optimization problem in Chapter 4 is as follows:

State variables:

WP = world price,
Q = production, and
GS = opening government stocks.

Control variables:

NP = procurement minus offtake, or net procurement,
M = imports, and
X = exports.

State transition equations:

(1) Q is an exogenous random variable, uncorrelated with past values for Q.

(2) WP moves in a random walk in the simulations. In the discrete world of dynamic programming, a random walk is not feasible without an unacceptably large number of allowable values for WP. The probabilities of moving from one level of WP to another are chosen so that the expected value of next year's price is never more than US$7 per ton above or below the present year's price.

(3) $GS_{t+1} = GS_t + NP_t + M_t - X_t$.

Behavioral equation:

The government chooses NP, which then determines price through the following two equations for consumption C:

$$C = Q - NP, \text{ and}$$
$$C = A \cdot P^e,$$

where A is a constant, P is the market price, and e is the own-price demand elasticity.

Objective function:

Minimize present and discounted future values of the following function:

$$GC = FC + aPV,$$

where GC is government cost (including financial costs and perceived costs of price variability), FC is fiscal cost, "a" is a weighting parameter, and PV is a measure of price variability.

Government fiscal cost, FC, is the sum of within-country operations, WCC, foreign trade costs, FTC, storage costs, SC, and a charge for the net change in value of stocks on hand over each 10-year cycle, RST:

$$\begin{aligned} FC &= WCC + FTC + SC + RST, \\ WCC &= P \cdot NP, \quad \text{and} \\ FTC &= M(WP + MC) - AID \cdot WP - X(WP - XC), \end{aligned}$$

where MC is the costs of importing, AID is food aid, and XC is the costs of exporting. Foreign exchange components of WP, MC, and XC are valued at a 10 percent premium above domestic components. Food aid, AID, is a set percentage of the shortfall in total supply below a certain level:

$$AID_t = 0.5[(Q^* - 500) - (Q_t + GS_t)],$$

where Q^* is normal production, and values are expressed in thousand tons. This formulation for food aid yields values somewhat lower than has occurred in the past. In some runs of the model presented in Chapter 4, AID is assumed to be zero.

The third element of fiscal cost is storage costs, modeled as an average cost STCOST per ton stored:

$$SC = STCOST \cdot GS.$$

The final element in fiscal cost values the change in stock from the beginning to the end of the cycle. If this is not included, policies that lower stock levels over time will appear more profitable than they should. The valuation of the stock change, however, should not depend on the random variable WP in the terminal year; that would be equivalent to forcing the exportation of all stocks, thus penalizing the optimal policies that hold more stocks in years of low world prices. Thus the stocks are always valued at the base year world price, regardless of the terminal year price:

$$RST = (GS_0 - GS_{10})WP_0.$$

Price variability, PV, is measured as the squared deviation from the target price, P^*:

$$PV = (P_t - P^*)^2.$$

The parameter "a" is varied in different optimization runs to map out the trade-off curve between price variability and fiscal cost.

For a more complete description of a similar model and a defense of this type of specification, see Pinckney (1988b, 31-49). The Fortran programs used in the optimization run on IBM PCs are available from the author on request.

APPENDIX 4: MARKETING COSTS

The total cost shown in Table 30, Rs740 million, averaged over the nationwide offtake of 3.7 million tons, is Rs200 per ton, the figure given in Table 31. Figures for North-West Frontier Province (NWFP) are detailed in Tables 32 and 33.

Table 30—Marketing costs to farflung areas, 1986/87

Area	Cost per Metric Ton	Quantity	Total Cost
	(Rs)	(million metric tons)	(Rs million)
Azad Kashmir, Northern Areas, Defense	400	0.4	160
Baluchistan	600	0.3	180
North-West Frontier Province (NWFP)	360	0.8	288
Karachi	225	0.5	112
Total	. . .	2.0	740

Sources: The costs are computed primarily from Agroprogress Kienbaum International BmbH and Indus Associated Consultants Ltd., "Foodgrains Storage and Processing Study," Annex 3.5.1 (report prepared for the Ministry of Food, Agriculture, and Cooperatives, Islamabad, 1986, Mimeographed); also Punjab Food Department and Pakistan Agricultural Supply and Storage Corporation (PASSCO) expenses for 1985/86 and 1986/87.

Table 31—Marketing costs of buying and selling, 1986/87

Type of Cost	Cost per Metric Ton
	(Rs)
Costs of Buying	
Fumigation	2
Bags	160
Delivery charges	10
Transport to storage center	8
Handling at storage center	10
Variable costs component of godown expenses and departmental charges	30
Total	220
Costs of Selling	
Handling during removal from storage	10
Costs of marketing and transport within Punjab and Sind	70
Average costs of transport and handling to farflung areas	200
Total	280

Sources: The costs are computed primarily from Agroprogress Kienbaum International BmbH and Indus Associated Consultants Ltd., "Foodgrains Storage and Processing Study," Annex 3.5.1 (report prepared for the Ministry of Food, Agriculture, and Cooperatives, Islamabad, 1986, Mimeographed); also Punjab Food Department and Pakistan Agricultural Supply and Storage Corporation (PASSCO) expenses for 1985/86 and 1986/87.

Table 32—Rates for transportation of wheat from Punjab to North-West Frontier Province, 1986/87

From Punjab to	Lowest Rate Approved per Metric Ton per Kilometer (Net Weight)
	(paisa)
Peshawar District	28.75
Mardan District	29.11
Kohat District	29.75
Abbottabad District	28.74
Mansehra District	31.95
Dargai Malakand Agency	29.74
Swat District	31.94
Bannu District	38.00
D. I. Khan District	40.99
Karak District	30.45

Source: North-West Frontier Province (NWFP) Food Department.

Table 33—Costs of transportation and incidentals for wheat handling in North-West Frontier Province, 1984/85-1986/87

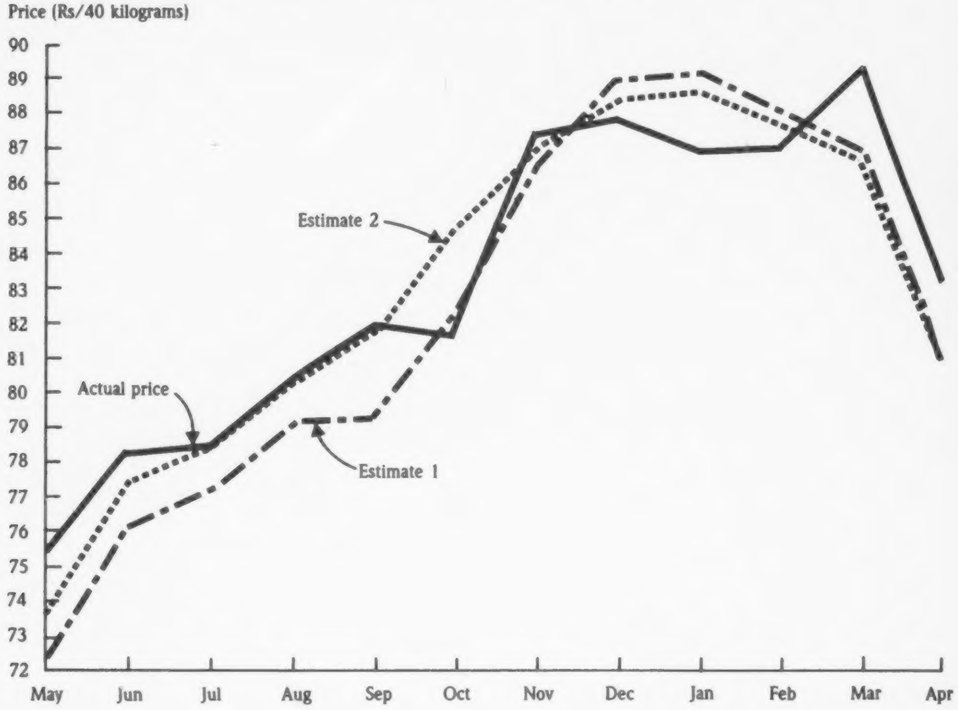
	1984/85		1985/86		1986/87	
	By Rail	By Road	By Rail	By Road	By Rail	By Road
			(Rs/metric ton)			
Transportation	50.01	262.90	48.73	286.28	51.17	300.59
Handling charges	1.28	1.28	1.63	1.63	1.71	1.71
Tax and duties	3.63	3.63	3.63	3.63	3.63	3.63
Godown expenses	6.72	6.72	1.45	1.45	1.52	1.52
Miscellaneous charges	12.79	12.79	14.16	14.16	14.87	14.87
Repair to storage bins	2.78	2.78	2.62	2.62	2.75	2.75
Storage surcharge	2.68	2.68	2.62	2.62	2.75	2.75
Interest	84.64	84.64	29.37	29.37	29.37	29.37
Railway freight	184.42	. . .	254.51	. . .	254.51	. . .
Total	348.95	377.42	358.72	341.76	362.28	357.19

Source: North-West Frontier Province (NWFP) Food Department.

In addition to these costs, the government incurs fixed costs per unit of storage capacity. These total about Rs80 per ton per year according to the Agroprogress and Indus (1986) study, and include permanent staff, electricity, depreciation, and other costs that do not go down if the facility is not used. These costs are not included in the model. To the extent that a change in policy allows for a smaller government storage capacity, further savings would be incurred through a decrease in these fixed costs.

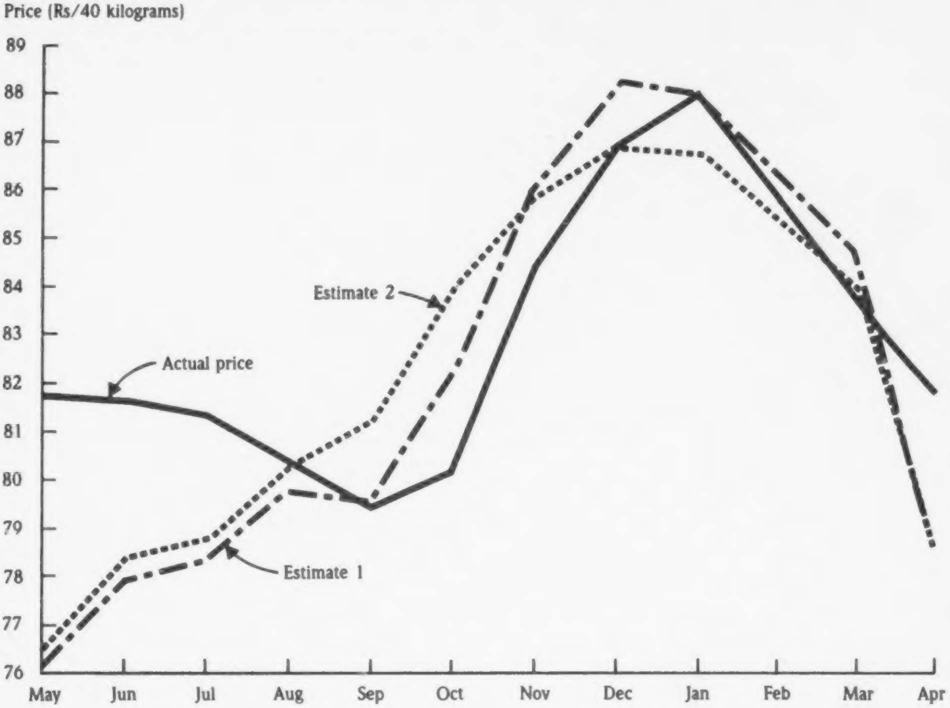
APPENDIX 5: SUPPLEMENTARY FIGURES

Figure 13—Actual and estimated prices of wheat in Pakistan, 1985/86



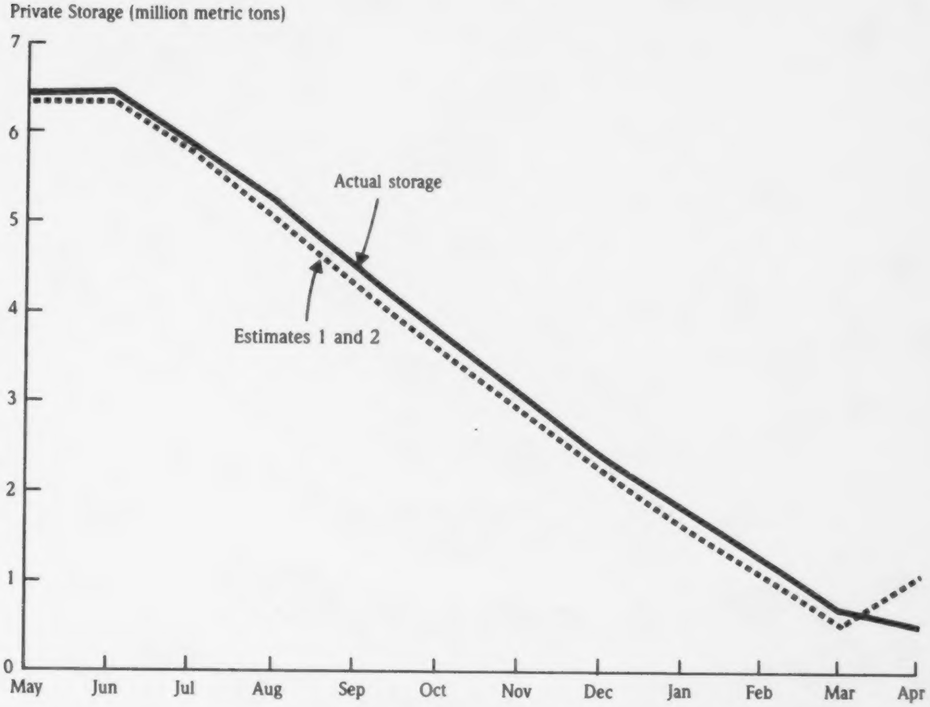
Note: Estimate 1 uses the original values of the A parameter listed in Table 20, after adjusting for population growth. Estimate 2 uses the revised values of the A parameter from the same table, again adjusting for population growth.

Figure 14—Actual and estimated prices of wheat in Pakistan, 1986/87



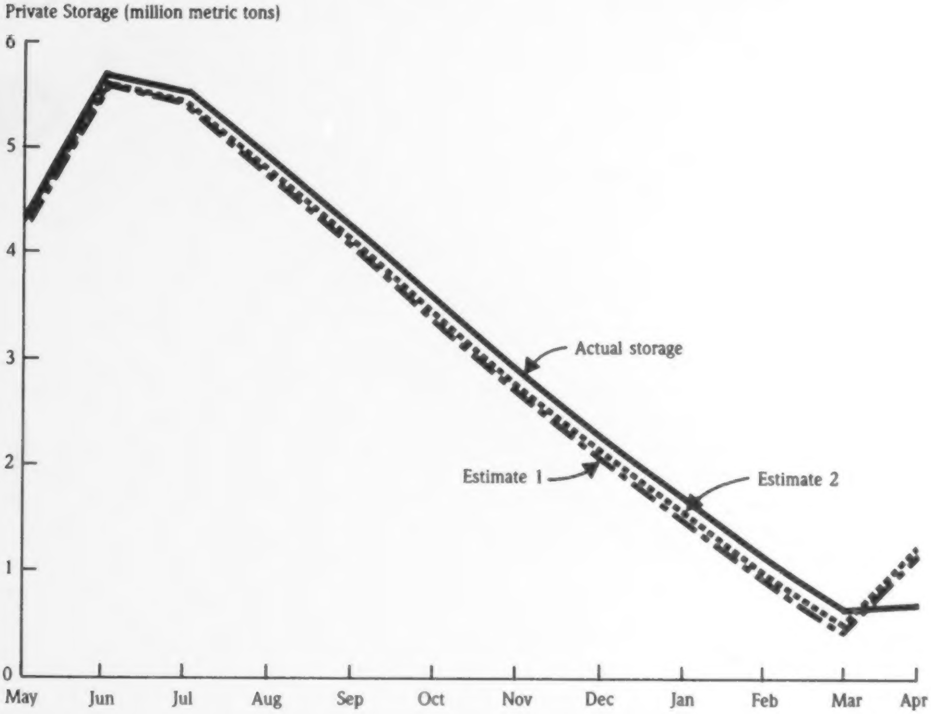
Note: Estimate 1 uses the original values of the A parameter listed in Table 20, after adjusting for population growth. Estimate 2 uses the revised values of the A parameter from the same table, again adjusting for population growth.

Figure 15—Actual and estimated private storage of wheat in Pakistan, 1985/86



Note: Estimate 1 uses the original values of the A parameter listed in Table 20, after adjusting for population growth. Estimate 2 uses the revised values of the A parameter from the same table, again adjusting for population growth.

Figure 16—Actual and estimated private storage of wheat in Pakistan, 1986/87



Note: Estimate 1 uses the original values of the A parameter listed in Table 20, after adjusting for population growth. Estimate 2 uses the revised values of the A parameter from the same table, again adjusting for population growth.

APPENDIX 6: FINANCING IMPORTS

Under any policy, there will be times when the opening supply stabilization stocks of the country are insufficient to meet the shortfall in supply because of random yield fluctuations. Such situations will require the use of foreign exchange for imports and the use of food aid. Although holding no interannual supply stabilization stocks may maximize net foreign exchange earnings in the long run, it can exacerbate the short-run problem of arranging for imports in deficit years.

The international community has attempted to address this difficulty and the parallel problem of a major production shortfall in an export crop. The Compensatory Financing Facility (CFF) of the International Monetary Fund (IMF) was introduced in 1963 to mitigate the adverse effect of export instability on the balance of payments of the countries that export primary commodities. The principal purpose has been to provide timely relief to members with payment difficulties arising from temporary shortfalls in their export earnings due to factors largely out of their control. The assumption is that these payment difficulties are only temporary and do not require policy reforms. The amount of the drawing is constrained by the size of the calculated shortfall, subject to a limit on outstanding drawings. The interest rate charged on CFF drawings is the same as that applied to other drawings from the IMF.

While the underlying rationale for the use of the CFF has not changed since 1963, there have been major changes in the scope and method of its operation. These changes include the commodity coverage of the facility, method of calculation, and maximum level of drawing. The CFF is not commodity specific, and shortfalls are related to total export earnings, including services such as workers' remittances. The drawings under the CFF are additional to what a member might draw under the normal lending facilities of the IMF. However, the maximum permissible amount of drawings has varied in terms of the members' quota limit. Periodic quota increases have allowed a substantial increase in maximum drawings in absolute terms.

In 1981, the CFF coverage was extended by permitting the optional inclusion of a temporary increase in the cost of commercial cereal imports. The objective of the Cereal Imports Excesses (CIE) provision is to minimize the effects of foreign exchange availability constraints by making loans to member countries that experience temporary surges in cereal import bills, thereby avoiding downward fluctuations in food consumption or inappropriate and costly policy adjustments.

Under the CIE the amount of a drawing is calculated as the sum of the export shortfall and cereal imports increase, with the total subject to limits on outstanding drawings. The shortfall is calculated in relation to a trend, defined as an average of the value of exports and cereal imports for five years, centered on the year of the export shortfall (or excess cereal imports). The trend calculation thus requires forecasts for cereal imports and total exports for two years into the future.

The CIE has a number of advantages over alternative food security schemes. It is less political than food aid, does not require any international agreement, allows countries to rely on imports rather than stockholding, and (at least in principle) can be immediately responsive to cereal production fluctuations or changes in the world price (Huddleston et al. 1984).

For some countries, the actual experience of the CIE has not met expectations, as the assistance provided has been deemed inadequate in relation to need. Supporters of this view suggest that the CIE should be the primary means by which food consumption shortfalls are met and that any corollary features of the provision that interfere with such an objective are counterproductive. Others argue that the CIE has not yet been tested because of low world prices since 1981, minimal shortfalls in cereal production, and abundance of food aid (which is cheaper than using the CIE).

One technical problem with the CIE arises from an IMF decision in 1983 integrating the CFF to the highly conditional financing of the upper credit tranches. Drawings on lower tranches now require a mission to assess whether policy adjustments may be necessary to address balance-of-payments difficulties. Drawings in upper tranches require the existence of a "satisfactory" balance-of-payments position or the existence of a broadly "satisfactory" performance under arrangement with the IMF.

Determination of the origin of a shortfall is straightforward when it is due to changes in international prices. The assessment is more difficult when changes stem from variations in quantities exported or imported or both. This is where cooperation requirements for drawings between the member country and the IMF become more influential. Since 1966, drawings that represent a relatively large percentage of a member's Fund quota (upper tranche) have become subject to increasingly higher levels of conditionality than drawings from a lower tranche. Particularly in the 1980s, long-term balance-of-payments difficulties have emerged that overshadow temporary shortfalls in export earnings or increases in cereal imports. This change in emphasis has affected the guidelines for drawing from the CFF and the CIE provision in both the lower and upper tranches.

Under current conditions, it is difficult to separate the effects of general balance-of-payments difficulties from those of export shortfalls or cereal import excesses. Concurrently, lower world prices for cereals and higher levels of food aid have guaranteed lower levels of drawings under the CIE provision.

A further element of uncertainty with regard to a country's eligibility under the CIE provision is introduced by the lack of clear definitions as to what is a "satisfactory" balance-of-payments position. Thus, the semiautomatic basis on which the CIE drawings were supposed to be made has to some extent been abolished during the recent years of acute overall balance-of-payments difficulties for so many less-developed countries (LDCs).

Currently, the interest charge on CIE drawings is 6 percent—low in comparison with international capital markets but high in comparison with the economic cost of food aid to recipient countries. The debt burden of so many LDCs today is a strong deterrent against expanding their foreign debt through such drawings. Nevertheless, the cost of the CIE is considerably less than the cost of building larger buffer stocks.

The CIE provision was reviewed in both 1985 and 1987, but no major changes in policy have been agreed upon. Possible modifications of the provision proposed for discussion at the 1987 review included liberalizing the conditions for low-income LDCs by reducing the interest charges and relaxing the three-year repayment rule. It was also hoped that discussions might focus on a complete divorce of the CIE provision from the CFF. This initiative had been proposed in 1981 but was rejected on the grounds that increased export revenues could offset excess import costs, thereby nullifying any potential balance-of-payments problems. These same issues will no doubt be those raised in any future review (one is scheduled for mid-1989), but the same factions are as strongly entrenched in their positions now as ever, and thus the prospect of major revisions seems unlikely at this point.

In sum, the CIE provision is one possibility for assisting Pakistan in years of shortfalls in wheat production. Although it is not ideal, the facility does provide foreign exchange for imports during periods when availability may be a problem.

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78

THE EFFECTS OF SUGARCANE PRODUCTION ON FOOD SECURITY, HEALTH, AND NUTRITION IN KENYA: A LONGITUDINAL ANALYSIS

Eileen Kennedy

December 1989

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FOREWORD

This research report by Eileen T. Kennedy is part of a major IFPRI effort to assess the effects of the commercialization of agriculture on production, consumption, and nutritional status of rural people in African, Asian, and Central American countries. It reports on the continuation of survey work first undertaken at the request of the government of Kenya in 1983. The original survey work was analyzed in Research Report 63, *Income and Nutritional Effects of the Commercialization of Agriculture in Southwestern Kenya.*

The follow-up study described in this report presents a rare opportunity to examine longitudinal data on a group of farmers in three periods: before they entered a contract arrangement for growing a commercial crop—sugarcane; during the period before they harvested their first sugar crop; and after the harvest. Moreoever, the study includes landless, merchant, and nonsugar-growing farm households, as well as the contract sugarcane growers at various stages in the commercialization of agriculture.

This longer-term analysis confirms the findings of the earlier study that commercialization has positive benefits stemming from increased household incomes and has no negative effects on the nutritional status of children in sugarcane-growing households. It is also clear, however, that commercialization is not a cure-all for childhood illness and malnutrition. Increased incomes must be accompanied by improved health and sanitation facilities if they are to have a major effect in reducing such illness and malnutrition.

Other recently published research reports in the commercialization of agriculture series include *Cooperative Dairy Development in Karnataka, India: An Assessment,* Research Report 64; *Nontraditional Export Crops in Guatemala: Effects on Production, Income, and Nutrition,* Research Report 73; and *Irrigation Technology and Commercialization of Rice in The Gambia: Effects on Income and Nutrition,* Research Report 75.

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1

SUMMARY

The issue of the health and nutritional effects of the commercialization of agriculture—more commonly called cash cropping—continues to be contentious. Proponents of the commercialization process see it as a means of improving the overall welfare of small farm households and providing employment opportunities for the rural landless. However, critics of cash cropping argue that not only have most of the potential benefits not materialized, but in many cases cash cropping has caused a deterioration in the health and nutritional status of households. Until recently the evidence has been ambiguous.

There is a complex set of linkages between cash crop production and, ultimately, the health and nutritional status of individuals in more commercialized households. Much of the prior research on commercialization and its effects on food security and nutrition has focused on only a limited number of these potential linkages, and it has therefore been difficult to assess the net impact of cash crop production.

In 1983, IFPRI embarked on a series of studies to evaluate the full range of effects of commercialization of agriculture on household food security, health, and nutrition. A study conducted in conjunction with the government of Kenya in 1984/85 in an area of southwestern Kenya undergoing a transition from maize to sugarcane production was part of this series.

The present research report builds on this 1984/85 baseline study. The earlier study compared sugarcane farmers who had received at least one payment for a sugar crop with nonsugarcane producers. The incomes of the sugarcane farmers were significantly higher than those of the nonsugarcane farmers; a major portion of the differential in incomes between the two groups was due to sugarcane.

The 1984/85 study was cross-sectional. A possible criticism of this type of research design is that it might overestimate the positive effects of sugarcane production because the sugarcane farmers may have been more economically advantaged prior to entry into the sugar scheme. The follow-up study, conducted from 1985 to 1987 provided the opportunity to redress this criticism. The baseline study included a group of farmers about to enter the sugarcane scheme. This group of new entrants had an income per capita of 1,956 Kenyan shillings (KSh), virtually identical to that of nonsugarcane producers (KSh 1,924). The new entrants were similar to the nonsugarcane farmers on other key socioeconomic and food consumption parameters as well. The follow-up study allowed the new entrants group to be tracked up to and following the time of its first sugarcane harvest. The longitudinal nature of the two studies combined is methodologically much stronger than most cash-cropping studies, allowing strong inferences to be made about the actual effects of sugarcane production.

There were two other reasons that a follow-up study was deemed important. First, two important types of households were not included in the baseline survey: the group of households relocated as a result of the creation of the sugarcane factory and the households employed by and living on the sugar estate. The government was particularly interested in how the relocated households had fared because it was considering building sugarcane factories in other areas of the country. The follow-up study included a random sample of both relocated households and those employed by the South Nyanza Sugar Factory (Sony).

Second, the baseline study was conducted in a drought year—1984. It was unclear whether the positive income findings related to sugarcane production would be replicated in a "normal" agricultural season. The follow-up study provided the opportunity to compare the agricultural production and income effects of sugarcane cultivation in a drought year (1984) with a nondrought year (1986).

Although all household incomes increased between the drought and the nondrought year, the size of the income increases differed by type of household. The biggest increases in income between the two time periods were for the new entrants and the landless. However the reasons for these income increases differ.

The longitudinal analyses reinforce the income results from the earlier 1984/85 survey. In following up the cohort households (the same households that were in both studies), the average income per capita of the new entrants group was KSh 1,129 higher than that of the nonsugarcane farmers. Part of this increment in income is due to marketed agricultural income. The new entrants earned KSh 791 per capita from commercial agriculture, compared with KSh 365 per capita for the nonsugarcane producers. In the earlier survey the incomes per capita from commercial agriculture for the new entrants and the nonsugarcane producers were similar—KSh 404 and 393, respectively. The entry into sugarcane production increased incomes in the new entrants households.

However, other forms of income also contributed to differences in incomes per capita between the new entrants and the nonsugarcane farmers. The new entrants not only did well in commercial agriculture, but the amount of income per capita earned from production used for own consumption was significantly higher for new entrants (KSh 1,761) compared with KSh 1,302 for nonsugarcane producers.

Surprisingly, the landless group of households is the lowest income group in both studies, yet it had one of the biggest increases in real income between the two time periods. The coping strategy used by the agricultural households during the 1984 drought—putting more land into production to compensate for lower yields per hectare—was not possible for the landless. Therefore, the drought affected their incomes more than other groups in the community.

What is clear from the income data is how diversified the income sources are for each type of household. The prototype of either a purely subsistence household or a totally commercialized household does not exist. Even agricultural households depend on nonagricultural sources for 33-41 percent of their total household income.

The study corroborates that income is the major determinant of household food consumption. Although the increased income associated with sugarcane production translates into improved caloric intake for the household, the link between income and calories is significant but weak. The income elasticity of demand for calories is 0.15 at mean levels of caloric consumption.

Higher household income also benefits the preschoolers. As household caloric consumption increases, children's caloric intakes also improve. Here again, however, the link between household calories and child calories is significant but weak. A doubling of household income (unlikely in the short term) would be insufficient to cover the preschoolers' caloric deficit.

Moreover, the increases in income associated with participation in the sugarcane scheme did not reduce the prevalence of illness in children or in women, at least in the three years covered by these surveys. One needs to be cautious in interpreting these data. It may seem counterintuitive that strongly significant increases in income do not convey a health benefit. The survey shows, however, that increased income in the sugarcane producing households is likely to be spent on items like education and housing, which while important, do not translate into less illness, at least in the short run.

These findings do not indicate that income is unimportant, but rather that increases in income must be combined with an improvement in the health and sanitation environment in order to bring about significant improvements in the nutritional status. The complementarities between increased income and an improved health situation should be stressed so that the potential effects of commercial agriculture for reducing malnutrition can be enhanced.

The 1984/85 study was conducted at a time when there was a popularly held belief that cash crop production caused malnutrition in children. There is no evidence from either the baseline survey or the more rigorous longitudinal analyses to suggest that sugarcane production is associated with an increase in malnutrition. The sugarcane scheme, as it has been implemented in the Sony area, has increased the incomes of smallholders in the program. This increased income has had a significant effect on household food security and a modest effect on children's caloric intake.

The data from the two Kenya studies suggest that increased household income based on the commercialization of agriculture can make a major contribution to the solution of the hunger problem, but it does not in itself provide a complete solution to the problem of preschooler malnutrition. Health and sanitation conditions should be improved in tandem with agricultural policies and programs in order to maximize the nutritional effects of income-generating policies.

2

RESEARCH DESIGN AND SURVEY METHODS

The health and nutrition effects of the commercialization of agriculture is a controversial issue. Whereas a number of studies have indicated that cash cropping has a negative effect on household food consumption and nutrition, other studies have reported positive or at least neutral effects.[1]

In 1984, at the request of the government of Kenya, IFPRI began a study to evaluate the income and nutritional effects of a shift from maize to sugarcane production. The government was concerned that in areas undergoing this transition to commercial agriculture, particularly the production of sugarcane, a deterioration in household-level food security and preschooler nutritional status was occurring.

This study was therefore initiated in South Nyanza, a sugar-growing area of Kenya, to evaluate the effects of cash crop production on agricultural production, income, and food consumption, and to assess the impact of cash cropping on the health and nutritional status of preschoolers and women. In addition, the research concentrated on identifying the processes that lead to these outcomes.

Results from the 1984/85 baseline study[2] indicated that there was a significant increase in incomes of sugarcane producers compared with nonproducers; most of the difference in income—73 percent—was due to the production of sugarcane. Increased income in turn had a significant, positive, though modest effect on the households' caloric intakes.[3] Despite the significant increments in household income, however, there was little effect on preschoolers' health or nutritional status. These results suggest that an increase in income may be a necessary but not sufficient condition for bringing about a significant improvement in child health.

A follow-up study was initiated in the same project area in December 1985 (ending in March 1987) to build upon the information collected in the June 1984 to March 1985 portion of the research. There were three major reasons for placing high priority on an additional wave of data collection.

First, IFPRI had already collected baseline socioeconomic, food consumption, and health and nutritional status information on a cohort of households prior to their entry into the smallholder sugarcane outgrowers' scheme, but the 1984/85 baseline study was not able to follow these households up to the time of first payment for the sugarcane crop because the time between planting and harvest is 24 months in the study area; the field costs would have been prohibitive. However, this group of households, called the "new entrants" group, was ready for its first sugarcane harvest between March 1985, when the baseline study ended, and December 1985, when the follow-up study began. Thus the data from the earlier study was used as a baseline for the follow-up study.

Most prior research on the topic of commercialization of agriculture has involved ex-post research only. Households have been studied only after they have already entered a cash cropping scheme, making it difficult to ascertain the health and nutritional status of households and individuals prior to making the transition to commercial agriculture. The follow-up study provided one of the few opportunities to follow farmers for whom baseline economic and health information was available up to and after payment for the sugarcane crop was received. Also, the new entrants to the sugarcane scheme were typical of the type of farmer that the government is trying to reach—the truly small, rural households.[4] In addition, data on income and consumption from the first study indicate that new entrants, prior to joining the outgrowers' program, were similar to nonsugar farmers on key socioeconomic and health variables.

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[1] For a review of much of the literature on the nutrition effects of the commercialization of agriculture, see von Braun and Kennedy (1986).

[2] For a detailed description of the survey design and research protocol, see Kennedy and Cogill (1987).

[3] In this report, all references to calories or caloric intake refer to kilocalories.

A second reason for the follow-up study was that the baseline study was conducted in 1984, a drought year for Kenya. There was some concern that the income and agricultural production statistics that were collected during that year might not be representative of a normal agricultural year. The follow-up study presented the opportunity to examine some of the issues in a typical agricultural year.

Lastly, two groups were not represented in the baseline study. Specifically, those households that were relocated as a result of the creation of the sugar factory were not part of the earlier study. In addition, households employed by and living on the sugar estate also were not included in the earlier study. The follow-up study in 1985-87 allowed a representative sample of these households to be included.

This report presents the results of the longitudinal analysis for the period June 1984 to March 1987.

Conceptual Approach and Survey Methods

Figure 1 presents a simplified conceptual model of pathways through which cash crop production can potentially influence health and nutritional status.[5] There are a complex set of issues and linkages that need to be understood in order to evaluate the effects of cash-crop production. Past work has tended to concentrate on a limited number of household-level effects—mainly household agricultural production. Noticeably absent from most studies is any research related to an assessment of cash cropping on intrahousehold dynamics.

Cash cropping can potentially influence household-level factors by affecting agricultural production, the demand for hired labor, and/or allocation of resources within the family (see Figure 1). A positive effect of commercial agriculture on one of these pathways could be offset by a negative effect in another area. By influencing any of the three pathways at the household level, cash cropping can also affect the health and nutritional status of individual family members. Figure 1 serves as the basis for conceptualizing the present study and design of the research protocol.

The process through which the commercialization of local agriculture may influence an individual's health and nutritional status is complex. To understand this process a series of household-level factors has to be linked to individual characteristics and, therefore, data have to be collected from the community, household, and individual household members. The types of variables included in both parts of the study and the method of data collection are described in Table 1.

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[4] A small farmer, as defined by the government of Kenya, has less than 8 hectares of land.

[5] For a detailed discussion of each of these pathways, see von Braun and Kennedy (1986).

Figure 1—Some linkages between cash crop production and nutritional status at household and intrahousehold levels

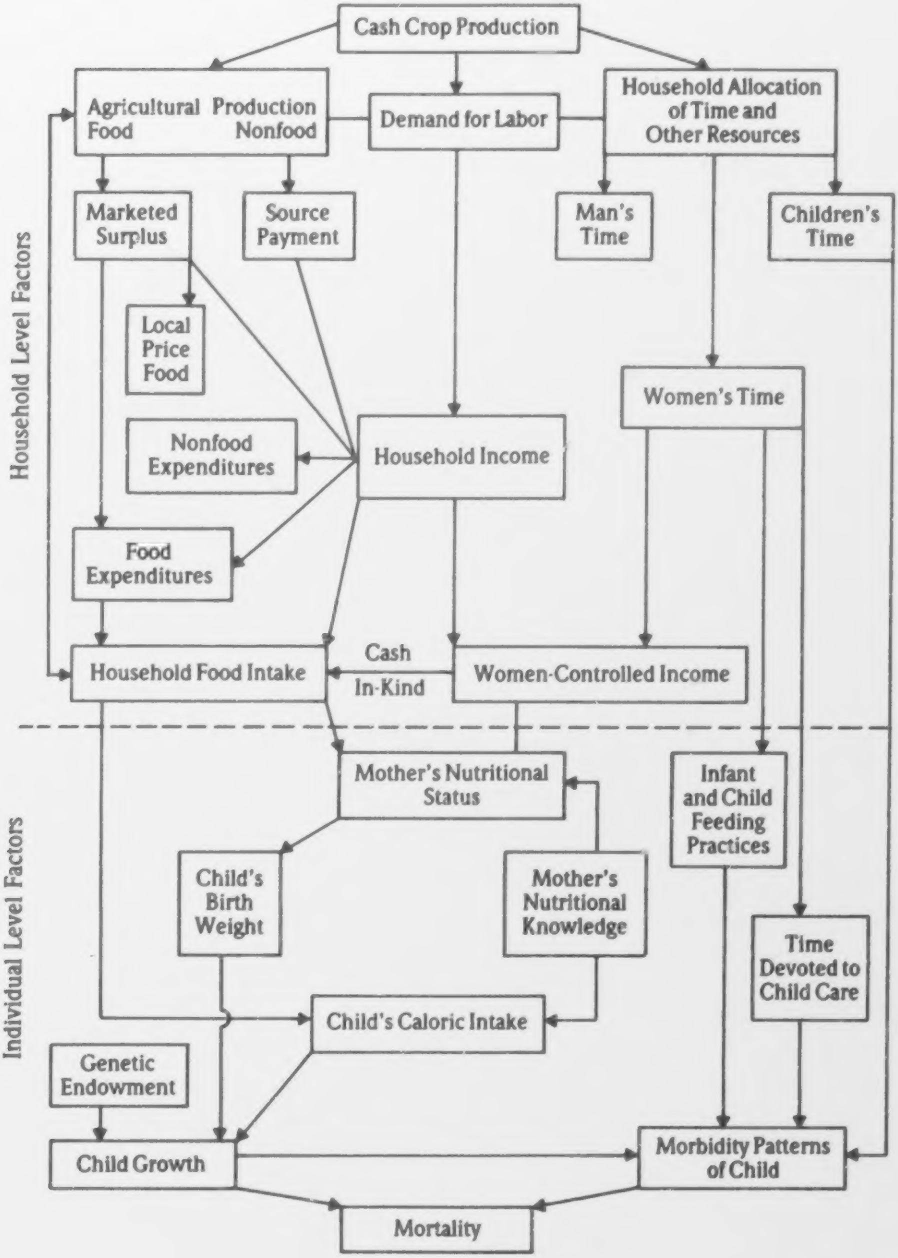
Cash Crop Production
Agricultural Production
Food
Nonfood
Demand for Labor
Household Allocation of Time and Other Resources
Marketed Surplus
Source Payment
Man's Time
Children's Time
Household Level Factors
Local Price Food
Women's Time
Nonfood Expenditures
Household Income
Food Expenditures
Household Food Intake
Cash
In-Kind
Women-Controlled Income
Mother's Nutritional Status
Infant and Child Feeding Practices
Individual Level Factors
Child's Birth Weight
Mother's Nutritional Knowledge
Time Devoted to Child Care
Child's Caloric Intake
Genetic Endowment
Child Growth
Morbidity Patterns of Child
Mortality

Table 1—Data collected in the survey, 1984-87

Variables	Round				Method	Frequency of Collection/ Period of Recall
	1	2	3	4[a]		
Community-level variables						
Food prices	x	x	x	x	Observe	Every two weeks
Nonfood prices	x	x	x	x	Observe	Periodically during the survey
Population				x	Record retrieval	Population statistics collected for 1984
Services available	x	x	x	x	Observe	Periodically during the study
Household-level variables						
Socioeconomic information	x				Recall	Once, at initial visit in each study
Income by source (agricultural, nonfarm, loans, other types)	x	x	x	x	Recall	Round 1 for prior six months; other rounds for the prior two months
Income by individual earner	x	x	x	x	Recall	Same as above
Food expenditures	x	x	x	x	Recall	Each round for prior seven days
Nonfood expenditures	x	x	x	x	Recall	Each round, flexible period of recall for each of the items
Energy consumption	x	x	x	x	Recall	Each round for prior 24 hours
Water (source, distance)	x				Recall	Once, differentiated by rainy and dry season
Sanitation (presence of latrine)	x				Observe	Once, at initial visit
Agricultural production (inputs by crop, production by crop)	x	x	x	x	Recall	Round 1 for prior growing season; other rounds for prior two months
Storage of crops and agricultural inputs	x	x	x	x	Recall	Each round, report on what is in storage at time of visit
Labor input by crop and task, by household (adult and child), and by hired workers	x	x	x	x	Recall	Same as for agricultural production
Women- and child-level variables						
Reproductive history	x	x	x	x	Recall	Once at initial visit, changes (births and deaths) recorded on subsequent rounds
Age	x	x	x	x	Recall	Once, at initial visit
Time allocation	x	x	x	x	Recall	Each round for prior day
Weight, length, and weight-for-length	x	x	x	x	Actual measurement	Each round
Preschooler energy intake	x	x	x	x	Recall by caretaker	Each round for prior 24 hours
Breastfeeding history and weaning practices	x				Recall by mother	Once, at initial visit, recall of birth to age of weaning
Morbidity patterns	x	x	x	x	Recall	Each round for prior two weeks
Mortality	x	x	x	x	Recall	Once, at initial visit, deaths of any children during survey were recorded

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

[a] There were four rounds in the baseline survey and four rounds in the follow-up survey for a total of eight rounds.

Study Area

The research for this study was conducted in a project area located in Nyanza Province, South Nyanza District, in the southwestern part of Kenya. Nyanza Province has historically been a grain-producing area, supplying basic staples for other parts of Kenya, but since the early 1970s, it has become part of the area known as the sugar belt of Kenya.

In 1977, the newest of the sugar factories in Kenya was established—the South Nyanza Sugar Factory (Sony). The Sony factory obtained approximately 2,500 hectares of land from local landowners to establish the factory and nucleus estate. The majority of sugar, however, is produced by smallholders under contract with the Sony Company.

The outgrowers' program includes 6,000 contract farmers and approximately 6,000 hectares of land. The outgrowers' program at Sony is similar to the outgrowers' programs used in other sugar schemes throughout Kenya. Farmers are under contract with the factory; the factory agrees to purchase sugarcane from the outgrowers at the price prevailing at the time of harvest. The price paid to the sugar producer is set by the Office of the President, Government of Kenya.

The normal cycle for sugarcane in the Sony area involves a plant crop and two ratoon (offshoot) crops. The time between planting and harvest for the plant crop is 22-24 months. The ratoon crops are harvested 18-19 months apart thereafter.

The factory provides services for a fee to the farmers involved in the outgrowers' scheme. Typically, the factory will survey the farmland to identify the acreage most suitable for sugarcane production. In addition, the factory may also clear the brush, prepare the land, provide seed and fertilizer, plow, weed, cut the cane, and transport the final crop. The extent to which the factory provides these services varies depending on the individual needs of the farmer and the availability of inputs from the factory. In 1983, the Sony factory implemented a "self-development" scheme, which requires the farmer to provide a greater proportion of the crop inputs. For example, new farmers wishing to participate in the outgrowers' program now have to clear their land themselves or have a cleared plot of land available. So, while the factory has historically supplied most of the crop inputs, this pattern has been changing. There is a charge for each of the factory-provided services, including an interest charge applied to each service and an administrative levy, which is deducted from the final payment for the sugarcane crop. Most crop inputs are supplied by the factory; the ratio of factory to nonfactory inputs is approximately 10:1.

Research Design and Sampling

The baseline survey included a representative sample of 504 households. Sony provided a list of all farmers in the outgrowers' scheme. From this list, a random sample of sugar farmers, weighted by sublocation, was chosen.[6] Each of the randomly selected households had to meet the following criteria: it had to have (1) at least one preschooler; (2) less than 20 hectares of land; and (3) a resident farmer in the household.

The presence of a preschooler in the household was important because the government of Kenya was specifically interested in evaluating the effects of commercialization of agriculture on the nutritional status of preschool-age children.

The group of sugar farmers chosen represented outgrowers in various stages of the scheme. As already mentioned, a contract with Sony normally lasts five years and includes a plant crop and two ratoon crops. The first sugar was planted in the area in 1978; farmers who planted in the early years of the outgrowers' program were already into the second contract period when fieldwork for the baseline study began in June 1984.

Since the Sony factory is the newest sugarcane scheme in Kenya, the outgrowers' program is still expanding. This provided the opportunity to identify a cohort of farmers prior to entry into the outgrowers' program or prior to the first sugar harvest and to collect baseline information on sociodemographic characteristics and health and nutritional status.

Of the 181 sugar farmers in the baseline study sample, 77 percent had received at least one payment for a sugar crop. This group is called the "sugar farmers" in this report. Twenty-three percent of the farmers had not yet had a first harvest and therefore had not yet received payment for any sugar harvest. This group is called the "new entrants."

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[6] A sublocation is the smallest administrative unit in Kenya.

Once the sample of sugar farmers was chosen, field staff identified the next nearest nonsugar farmers who met the same selection criteria.[7] The nearest-neighbor method of sampling nonsugar farmers essentially enabled the use of the sugar farmer as a seed unit by mapping all neighbors who did not grow sugar. For each sugar contractor, mapping was performed on comparable households of up to three neighbors, up to two of which were randomly selected. This approach ensured geographic similarity of sugar and nonsugar farmers.

Because the research was concerned with the effect of the sugar scheme on the entire area served by the factory, it was important to have a representative sample of all types of households, including nonagricultural households. This community-assessment approach has typically not been done in prior studies. Yet the households not directly involved in cash-crop production may be affected the most. For example, if the new commercial crop is more labor-intensive than the crop it replaces, landless laborers may benefit most by the transition from semisubsistence to commercial agriculture because more hired labor may be required. If the opposite is true, landless laborers will be adversely affected. Therefore, landless households were randomly selected through a restricted area census of all families without land living in the eight small villages of the project area.

Finally, all businesses in the main township—Awendo—and the eight villages in the project area were mapped. From these lists, a random sample of local merchants was selected.[8] Many of the merchant households were also involved in agriculture; for the present study, a household was defined as a "merchant" if the major source of household income was supplied by the business activity.

Of the 504 households in the baseline study, 462 or 92 percent of these households remained in the follow-up study. The group of households that participated in both the baseline and follow-up studies is called the "cohort" sample. Because the present report relies heavily on a longitudinal analysis, the data presented will be based primarily on the cohort sample.

There are, however, two groups not part of the baseline study who were added to the follow-up study. Approximately 2,500 households were relocated when the Sony sugar factory was constructed. The government is particularly interested in how these relocated households have fared. Kenyan policymakers are currently discussing establishing new sugar factories, and they wish to use the information on the relocated households to guide future programs. The relocated households, randomly selected from a master list of households supplied by the Ministry of Agriculture, had to meet the same criteria as the farmers selected earlier.

Another group not part of the baseline study was those households employed by Sony and living on the Sony sugar estate. This group—the Sony employees—was included in the follow-up study. They were randomly selected from a housing list provided by the Sony management. The sample was weighted by type of housing. For example, most of the housing at Sony is for semiskilled workers. These manual workers, therefore, represent a greater proportion of the follow-up study sample than the administrative staff at Sony. Most of those in the Sony employee group are workers on the nucleus estate operated by the sugarcane company.

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[7] That is, to be selected, nonsugar farmers also had to have a preschooler, less than 20 hectares of land, and had to be resident farmers.

[8] The merchant households had to meet the same selection criteria as sugar and nonsugar farmers. Some merchants own land, but their primary source of income is from business.

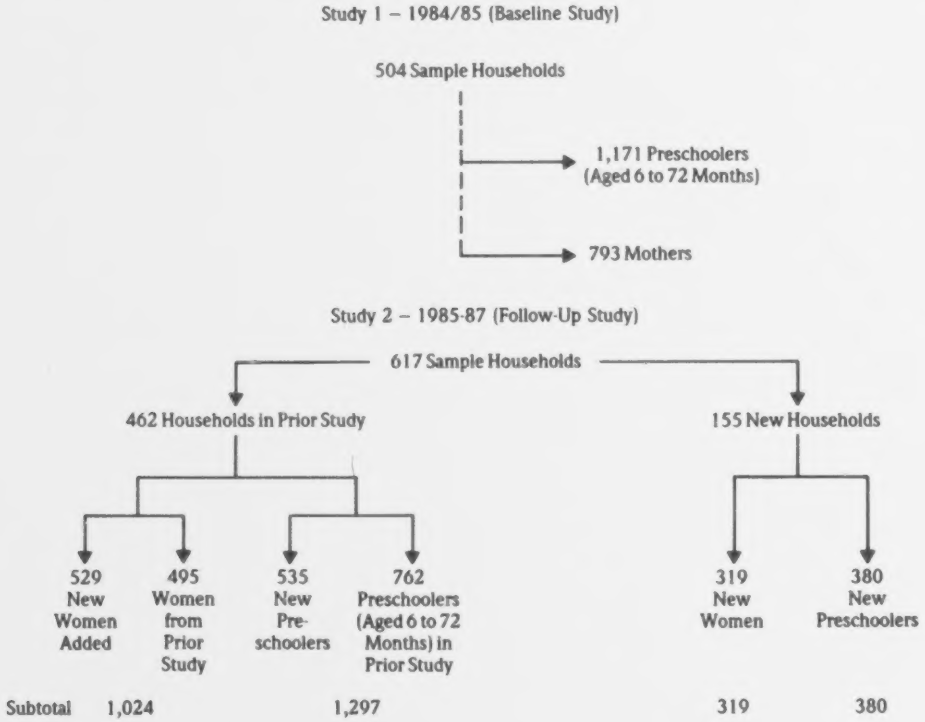
The cohort sample plus these two additional groups—the relocated households and the Sony employees—comprise the total sample. Results from the total sample will be presented only where they differ from the cohort sample.

In both studies, the proportion of agricultural households is approximately 80 percent. The study area remains a predominantly agricultural community.

Preschoolers and women were also traced from study 1 to study 2. Of the 1,171 preschoolers aged 6 to 72 months, 762 remained in the follow-up study. Children dropped out from the follow-up study primarily because they reached their sixth birthday. However, some were also lost to follow-up because of death or migration to another area. A total of 535 preschoolers were added to those in the baseline study due to births and in-migration of new children.

For women, the pattern is similar. Of the 793 mothers in the baseline study, 495 remained, but 529 new women were also added from households that were in the baseline study. The major reason for the addition of new women was a difference in the sampling approach used. In the baseline study, only mothers of preschoolers were included. In the follow-up study, all women in the study households were included. In the follow-up study, 319 women and 380 preschoolers were included from newly entered households. A schema for the samples in the baseline and follow-up studies is presented in Figure 2.

Figure 2—Composition of samples in 1984/85 and 1985-87 studies


Study 1 – 1984/85 (Baseline Study)
504 Sample Households
1,171 Preschoolers (Aged 6 to 72 Months)
793 Mothers
Study 2 – 1985-87 (Follow-Up Study)
617 Sample Households
462 Households in Prior Study
155 New Households
529 New Women Added
495 Women from Prior Study
535 New Pre-schoolers
762 Preschoolers (Aged 6 to 72 Months) in Prior Study
319 New Women
380 New Preschoolers
Subtotal
1,024
1,297
319
380

Grand Total: Households – 617
Women – 1,343
Preschoolers – 1,677

3

CROPPING PATTERNS IN SOUTH NYANZA

In many parts of Kenya, 1984 was a drought year. In the study area, it was the late arrival of the long rains (delayed by almost two months), rather than an absolute deficit in rainfall that created problems for local agriculture in 1984. The follow-up study in 1985/86 provided the opportunity to assess agricultural production in a "normal" rainfall year and to contrast this with results from the earlier study.

Farming Systems in South Nyanza

Maize is the main staple crop grown in South Nyanza. All crops are grown under rainfed conditions. There is a bimodal pattern of rainfall with one long and one short rainy season. The long-rains period is the major season for production of staples.

Maize planting for the long-rains growing season is done in February or March with harvesting in late July or August, and that for the short rains begins in September with a harvest in February. Sugarcane planting and harvesting is carried out throughout most of the year.

Table 2 presents a profile of the cropping patterns for the new entrants, sugar farmers, and nonsugar farmers during the long rains of 1984 and 1986. From these data for two separate long-rains seasons, it can be seen that nonsugar farmers have a different cropping pattern from sugar farmers. A significantly smaller percentage of total farm area is devoted to all crops by nonsugar farmers, compared with sugar farmers. This is true for both time periods studied.

The larger percentage of land devoted to all crops by sugar farmers is reversed when just food or edible crops are compared (see Table 2). Sugar farmers have a significantly smaller percentage of their land in food crops compared with nonsugar farmers in each of the time periods presented.

Most of the difference between land allocated to all crops and land allocated to food crops alone is accounted for by contracted sugarcane. For the new entrants group, 94 percent of the difference in total cropped land versus food cropped area in 1986 is due to sugarcane; for the sugar producers, sugarcane accounts for 98 percent of the difference between total cropped and food crop area.

The sugarcane outgrowers' program has enabled farmers to put a greater proportion of land into production without much additional household labor, since the factory supplies most of the labor required for sugarcane cultivation. The charge for this factory-provided labor is recouped from the payment for the sugarcane crop. The factory has changed the credit environment in the community and by doing so has increased the availability of nonhousehold labor for sugarcane production.

The labor constraint at the household level is reflected in part by the area per capita put into food production. The agricultural households during the long rains of 1986 used only 44 to 58 percent of land for crop production. Clearly, if households could put more land into production, their incomes would increase. However, as already mentioned, household labor is limited and credit to pay for hired labor is also not easily accessible.

Although both the new entrants and sugar farmers are involved in sugarcane cultivation, the degree of involvement varies. In 1986, sugar farmers devoted 47.8 percent

Table 2—Characteristics of farming patterns of agricultural households, cohort sample, 1984 and 1986

	1984 Long Rains			1986 Long Rains		
Farm Data	New Entrants	Sugar Farmers	Nonsugar Farmers	New Entrants	Sugar Farmers	Nonsugar Farmers
Farm size (hectares)	5.0	5.6	3.7	5.0	5.1	3.4
Mean number of plots	5.8	7.5	6.6	7.0	7.0	5.9
Mean number of crops	7.4	10.1	8.8	8.4	8.6	7.2
Percentage of farm area devoted to all crops	51.7	66.9	56.6	55.6	58.2	44.4
Percentage of farm area devoted to food crops	36.4	36.0	52.1	31.4	29.6	40.3
Mean area devoted to food crops (hectare/capita)	0.19	0.18	0.19	0.17	0.14	0.14

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

of their land to contracted sugarcane, compared with 40.6 percent for the new entrants group (Table 3). For the new entrants, the average plot size for contracted sugar was 0.91 hectares compared with 1.36 hectares for the sugar farmers. The new entrants group tended to have smaller plots because many of these households joined the outgrowers' scheme in late 1983/84 during the "self-development" program when farmers were required to provide their own labor to develop the plot or to put a cleared piece of land into production. Given that much more of the work in developing these

Table 3—Share of land allocated to specific crops, by agricultural household, long rains, 1984 and 1986

	1984 Long Rains			1986 Long Rains		
Crop or Crop Mix	New Entrants	Sugar Farmers	Nonsugar Farmers	New Entrants	Sugar Farmers	Nonsugar Farmers
	(percent)					
Local maize, single stand	11.9	10.4	24.9	18.0	14.5	28.5
Local maize and beans	3.7	3.2	5.1	2.5	2.7	6.6
Local maize and other crops[a]	4.2	5.3	8.1	6.1	4.7	10.6
Hybrid maize, single stand	11.4	6.1	7.7	8.6	12.1	15.9
Hybrid maize and other crops[a]	5.4	5.8	6.4	7.2	4.7	4.0
Other crop combinations	[b]	[b]	[b]	0.7	1.0	1.3
Sorghum and millet	10.0	8.4	16.6	1.1	0.7	2.0
Finger millet	0.7	1.0	0.5	. . .	. . .	0.7
Cassava	2.7	3.1	6.0	4.0	3.7	5.3
Tobacco	. . .	0.1	0.2	0.7	0.7	2.6
Sony sugar	45.5	47.9	. . .	40.6	47.8	. . .
Other sugar	0.08	0.03	0.03	2.2	0.7	6.6
Other crops	[b]	[b]	[b]	8.3	6.7	15.9

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Notes: Fallow, woodlands, and pasture are not included in estimates. The ellipses indicate a nil or negligible amount.

[a] For the 1984 long-rain season, peanuts were grown with local and hybrid maize.

[b] Data were not available for the 1984 harvest.

plots was done by household labor, not factory labor, it is not surprising that the plots of land devoted to sugarcane are often smaller.

When specific crops are examined (Table 3), it is apparent that nonsugar farmers placed greater emphasis on food or edible crops. More than 50 percent of their cultivated land is under maize crop production in both the baseline and the follow-up studies. In both a normal production year (1986) and a drought year (1984), nonsugar farmers grew more sorghum, millet, and cassava—crops that are associated with more traditional diets in the region. However, for each type of agricultural household, more land was used to produce drought-resistant crops like sorghum, millet, finger millet, and cassava in the 1984 drought year than in 1986. It appears that the use of these less preferred crops was one way to insure against potential losses of the maize crop in the drought year.

The proportion of land devoted to food crop production declined between 1984 and 1986 for each category of agricultural household. However, because of higher yields per hectare for both local and hybrid maize, household food security actually improved between the two time periods. Table 4 summarizes the single-stand maize production for the long rains in 1984 and 1986. The total household farm area devoted to local or hybrid maize tends to be small, ranging from 0.3 to 0.8 hectare in 1984 and 0.3 to 0.5 hectare in 1986.

Table 4—Production characteristics of local and hybrid maize, by agricultural households, long-rains season

	1984 Long Rains			1986 Long Rains		
Crop/Production Characteristic	New Entrants	Sugar Farmers	Nonsugar Farmers	New Entrants	Sugar Farmers	Nonsugar Farmers
Local maize						
Number of households growing crop	27	102	183	36	28	62
Total area (hectares)	0.4 (0.5)	0.7 (0.7)	0.8 (0.9)	0.4 (0.2)	0.4 (0.2)	0.3 (0.2)
Yield (kilogram/hectare)	962.7 (1,103.0)	864.2 (562.0)	845.2 (661.0)	1,321.0 (801.0)	1,455.0 (738.0)	1,345.0 (770.0)
Amount sold (kilograms/hectare)	101.1 (358.2)	74.1 (189.4)	85.9 (225.4)	104.0 (219.0)	74.0 (191.0)	219.0 (454.0)
Percentage of production kept for own consumption	89.5	91.4	89.8	92.1	94.9	83.8
Hybrid maize						
Number of households growing crop	19	54	76	18	16	25
Total area (hectares)	0.4 (0.7)	0.4 (0.8)	0.3 (0.5)	0.4 (0.4)	0.5 (0.3)	0.4 (0.3)
Yield (kilograms/hectare)	876.2 (678.4)	990.8 (714.9)	987.5 (949.8)	1,398.0 (883.0)	1,302.0 (624.0)	1,544.0 (926.0)
Amount sold (kilograms/hectare)	124.1 (203.8)	117.4 (318.2)	127.8 (328.9)	188.4 (303.0)	2.7 (11.0)	7.6 (27.0)
Percentage of production kept for own consumption	85.8	88.2	87.1	86.5	99.6	99.5

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Notes: All plots where maize is grown alone are counted here—not plots where maize is intercropped. The numbers in parentheses are standard deviations.

The similarities in production among the different types of households are striking for both years. Maize yields were lower than usual for everyone in 1984 due to the late arrival of the rains. In 1986, the yields for both local and hybrid maize were approximately 60 percent higher for all types of agricultural households.

Results indicate that household food production has not deteriorated as a result of the production of sugarcane. The area per capita devoted to food production is similar for sugarcane and noncane producers. The land devoted to sugarcane by both the new entrants and sugar farmers has primarily come from additional land being put into production. New entrants and sugar farmers have maintained maize production, despite entering the sugarcane scheme.

In 1984 maize yields were similar for both hybrid and local maize, which suggests that there is little advantage in using the purchased hybrid variety. In 1984, the poor performance of the hybrid variety was thought to be partially the result of the poor climatic conditions. In 1986, however, which was an average rainfall year, there was again no significant difference between the yields for local and hybrid maize. In fact, yields were lower than expected for both types of maize.[9]

Adverse climatic conditions are but one reason for lower-than-expected yields. Use of any type of fertilizer, particularly inorganic fertilizer, is extremely low for the food crops; 70 to 80 percent of the agricultural households use no fertilizer on any of the food crops. Even for the two major cash crops, sugarcane and tobacco, 33-40 percent of farmers use no inorganic fertilizer.

Soil quality also affects yields. In 1984, 63-64 percent of farmers ranked the soil in plots where sugarcane was grown as good quality. In contrast, only 46-47 percent of farmers ranked soil quality as good where other crops were grown.

The pattern for local maize was similar in 1986, only 48.2 percent of farmers ranked plots where local maize was grown in the long-rains season as good. Although the majority of farmers growing sugarcane during the 1986 long-rains season still ranked the soil in these plots as good quality, the proportion of "good" plots dropped from 64.8 to 51.0 percent. This may indicate that some marginal sugarcane plots were beginning to be put into production.

Labor is the major input used for most crops in the region, except sugarcane. Household labor for sugarcane averages only 45 person-days per hectare per year, much less than is used in food crop production.

Labor data for the major food crops—local maize, hybrid maize, and sorghum—are shown in Table 5. The total amount of labor for these crops was higher in 1984 than in 1986 for each type of agricultural household. The late arrival of the long rains in 1984 meant that fields that had been prepared in February had to be prepared again and planted two months later. This added, on average, an additional 30-40 days of labor per hectare for most of the major crops. For local maize and sorghum in both 1984 and 1986 the amount of household and hired labor was similar for sugar- and nonsugar-growing households.

In the baseline survey, household labor data were not disaggregated by gender. It was assumed, incorrectly, that most of the household labor devoted to food crop production was female labor. A breakdown of the amount of labor used by gender for the three types of agricultural households in the two studies is given in Table 6. Women provided the major portion of household labor for most of the food crops. Men provided

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[9] Estimates of the government suggest yields of 2,000 kilograms per hectare for this region of the country (Kenya 1982).

Table 5—Household and hired labor for major crops, by agricultural households, long rains, 1984 and 1986

Study/Crop	New Entrants Household Labor	New Entrants Hired Labor	Sugar Farmers Household Labor	Sugar Farmers Hired Labor	Nonsugar Farmers Household Labor	Nonsugar Farmers Hired Labor
			(person-days/hectare)			
Study 1, long rains						
Local maize	145	4	147	8	148	8
Hybrid maize	164	4	110	22	188	15
Sorghum	109	2	161	5	169	6
Study 2, long rains						
Local maize	98	5	105	7	102	6
Hybrid maize	109	7	79	4	121	6
Sorghum	88	2	102	5	113	8

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Notes: In person-days per hectare, adult men and adult women are weighted equally and child labor equals one-half adult labor.

approximately 40 percent of the total labor for each of the three main food crops. For hybrid maize, the major portion of labor for new entrants and nonsugar farmers was provided by men within the household. In addition, for some specific tasks, men accounted for the major portion of the time spent on each food crop (Tables 7 and 8). For example, for tasks such as land preparation and hoeing and smoothing, men provided virtually all of the labor. Similarly, for functions like weeding, women within the households did the majority of the work. The small amount of child labor that was used was primarily during the short rains.

Household labor data for local maize are also analyzed to determine the share of plots controlled by women versus those controlled by men (Table 9). Here again, even when the primary person responsible for a particular plot is a woman, a significant amount of male labor is provided, especially for tasks such as land preparation, hoeing, and smoothing.[10] However, during both the long and short rains, men put in more labor on plots controlled by men than on plots controlled by women. Moreover, in both growing seasons, men used more child labor on the plots they controlled.

Table 6—Allocation of labor within households for major food crops, long rains, 1986

Crop	New Entrants' Household Labor Men	New Entrants' Household Labor Women	New Entrants' Household Labor Children	Sugar Farmers' Household Labor Men	Sugar Farmers' Household Labor Women	Sugar Farmers' Household Labor Children	Nonsugar Farmers' Household Labor Men	Nonsugar Farmers' Household Labor Women	Nonsugar Farmers' Household Labor Children
					(person-days/hectare)				
Local maize	43	49	6	48	53	4	44	54	4
Hybrid maize	55	49	4	33	45	1	62	54	5
Sorghum	31	48	10	41	60	1	34	76	3

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

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[10] This pattern holds true for other major food crops as well.

Table 7—Share of labor provided by men, women, and children, by task, in agricultural households for major crops, 1985-87

Task	Long Rains			Short Rains		
	Men	Women	Children	Men	Women	Children
	(percent)					
Land clearing	85	14	1	77	20	3
Hoeing and smoothing	80	16	4	78	18	4
Fertilizer application	33	66	1	31	52	17
Planting	39	58	3	36	59	5
Weeding	34	62	4	33	60	7
Harvesting	17	79	4	13	80	7
Processing	0	99	1	0	100	0
Marketing	3	95	2	2	97	1

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Note: Crops include local maize, hybrid maize, sorghum, millet, and cassava.

For each of the food crops, the allocation of household labor is much higher than that used in sugarcane production. For a 24-month plant crop cycle, sugarcane requires approximately 90 days of household labor. A similar 24-month cycle in which four maize crops were raised in nondrought years would require 362 days of household labor. The low level of household labor devoted to sugarcane is due to mechanization in the outgrowers' program. Many tasks, such as land clearing, planting, and harvesting, are done by the factory.[11] This substantially reduces the need for household labor. If these tasks were not mechanized or done by the factory, household labor input would have to be approximately 50 percent higher than it currently is.

Weeding and harvesting the plant crop accounts for KSh 1,516 of charges,[12] most of which represent factory-provided wage labor. At a 1980 wage rate of KSh 12 per

Table 8—Days of labor provided by men, women, and children in agricultural households, by task, 1985-87

Task	Long Rains				Short Rains			
	Men	Women	Children	All	Men	Women	Children	All
	(person-days/hectare)							
Land clearing	7.6	1.5	0.2	9.3	7.9	3.2	0.5	11.6
Hoeing and smoothing	10.8	2.6	0.8	14.3	11.7	4.4	1.1	17.2
Fertilizer application	6.4	11.6	0.1	18.1	2.5	3.6	1.8	7.9
Planting	6.2	7.0	0.4	13.6	5.0	7.4	1.0	13.4
Weeding	18.3	26.7	2.3	47.3	14.9	33.7	3.4	52.0
Harvesting	3.6	15.1	0.8	19.5	2.4	10.0	1.1	13.5
Processing	0.0	6.3	0.1	6.4	0.0	3.6	0.0	3.6
Marketing	0.2	8.2	0.2	8.5	0.6	6.3	0.1	7.0
Total days	53.1	79.0	4.9	137.0	45.0	72.2	9.0	126.2
Percentage of total days	39.0	58.0	3.0	100.0	36.0	57.0	7.0	100.0

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

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[11] This has always been true except for the self-developed plots.

[12] All cost data are converted to 1980 Kenyan shillings (KSh 16 = US$1.00).

Table 9—Share of labor provided by men, women, and children, by task, in agricultural households on women-controlled versus men-controlled plots of local maize, new entrants only

Task	Long Rains						Short Rains					
	Women-Controlled Plots			Men-Controlled Plots			Women-Controlled Plots			Men-Controlled Plots		
	Men	Women	Children	Men	Women	Children	Men	Women	Children	Men	Women	Children
	(percent)											
Land clearing	79	21	0	100	...	...	78	22	0	78	22	0
Hoeing and smoothing	77	19	4	74	20	6	82	17	1	80	16	4
Fertilizer application	...	100	...	...	100	...	32	63	5	43	32	25
Planting	42	55	3	44	49	7	45	52	3	48	48	4
Weeding	38	60	2	39	54	7	35	58	7	43	51	6
Harvesting	16	82	2	30	64	6	7	82	11	12	79	9
Processing	0	100	0	...	100	...	...	100	...	...	100	...
Marketing	0	100	0	...	100	...	...	100	...	...	100	...
Total labor	40.0	47.3	2.4	50.2	51.8	11.4	31.7	42.1	4.4	38.4	44.8	6.2

Sources: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Notes: This table is based on the new entrants sample only. Results are similar for sugar and nonsugar household groups. The ellipses indicate a nil or negligible amount.

day, the KSh 1,516 in charges amounts to 126 days of hired labor per hectare generated as a result of sugarcane production. The amount of factory-provided labor has substantial, positive implications for wage-earning opportunities for the landless in the area.

Sugarcane Production Costs, Yields, and Income

Kenya became self-sufficient in sugar for the first time in 1979. In 1980 and 1981, there was a small exportable surplus of sugar. By the mid-1980s, however, Kenya was again faced with the situation of being unable to meet the domestic demand for sugar. The current goal of the Kenyan government is to increase sugar production to at least cover domestic needs.

Smallholders are the primary producers of sugarcane in Kenya: their production of sugarcane increased from 30.2 percent of total deliveries in 1976 to 44.4 percent of total supplies in 1980. It is expected that the prominent role of the small farmer in sugarcane production will continue.

Table 10 summarizes cost, yields, and income per hectare for each of the three harvests during the period 1978-86. The total cost of factory inputs for the plant crop was approximately two-and-one-half to three times the input charges for the ratoon crops. Two factors account for this dramatic difference in input costs. First, many of the factory charges are on a one-time-only basis—land clearing, surveying, grading, plowing, harrowing, furrowing, intercultivation, and seed cane planting. The cost of these inputs and services are recouped from the first harvest.[13] Second, yields generally decrease between the first, second, and third harvests; therefore, the cost of any input that is based on tonnage—such as harvesting or transportation—also decreases from the first to the third harvest.

This pattern of decreasing yields is consistent with data from the sugar factory management. For a well-maintained crop, the factory expects to see a 15 percent decrease in yield between the plant crop and first ratoon and an additional 15 percent decrease in yield between the first and the second ratoon. The data in Table 10 show a 40 percent decrease in yield between plant crop and first ratoon. This decrease in yield may be much larger than that seen on the factory experimental plots for a number of reasons, including suboptimal use of fertilizer. Yields on the plant crop may not be affected by inadequate fertilizer use, but the yields on ratoons will be substantially reduced if fertilizer is not applied.

It may seem surprising that farmers use less fertilizer than is optimal given that fertilizer is available from the factory. The choice of whether to use it, however, is left entirely to the farmers. In addition, there were periods in late 1983 and 1984 when fertilizer supplies from the factory were in short supply.

The net income per hectare is fairly stable across the three harvests despite the large decline in yields, largely because of the concurrent decrease in total cost of inputs per hectare. The net income per hectare per month of production and the net income per day of family labor are positive for each of the three harvests. The daily agricultural wage rate in the area during the follow-up study period was in the range of KSh 16-20, or in 1980 values, approximately KSh 12. Data in Table 10 show that the returns to household labor from sugarcane, using 1980 shillings, are four to five times higher than the daily agricultural wage rate.

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[13] The one exception is land clearing charges, which are sometimes recouped from the second as well as the first harvests.

Table 10—Summary of yields, income, and costs per hectare of sugarcane, by harvest, 1978-86

Yield/Income/Cost of Inputs	Plant Crop	Ratoon 1	Ratoon 2
		(KSh)	
Yields per hectare (metric tons)	102	57	51
Total cost of factory inputs per hectare	12,362	4,614	4,093
Total cost of contract inputs per hectare	779	197	188
Total net income per hectare[a]	3,390	3,027	3,520
Total net income per hectare per month[a]	141	168	196
Total net income per day of family labor[b]	49	68	77
Sample size (number of plots)	203	120	58

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya. For labor days, Republic of Kenya, *Soils of Kisii* (Nairobi: Government Printer, 1982).

Notes: All cost data are in real terms in Kenyan shillings, with 1980 used as a base year.

[a] All charges for factors of production, including household labor, have been subtracted out of this calculation. Charges for hired labor have also been deducted.

[b] Labor days are based on Government of Kenya labor estimates.

Not all of the input, yield, and income information can be verified from factory records. However, the results for verified data are similar to data for the larger sample.

The data in Table 10 indicate that, on average, sugar farmers are earning a return to family labor that is substantially better than an equivalent time spent as an agricultural wage laborer. However, these aggregate data mask the year-to-year variations in yields and income. Table 11 breaks down input, yield, and income information by year of planting for 1978-84. Late 1979 and 1980 were particularly bad periods for planting because of the limited rainfall in the area. These adverse climatic conditions affected yields, which in turn influenced income. The net returns per day of family labor for 1979 and 1980 were lower than normal but still twice the daily agricultural wage rate. The significant increase in net income between the 1980 and 1981 plantings was the result of an increase in yield, an increase in the cane price, and a decrease in cost of factory inputs.

The majority of farmers in the outgrowers' program did not experience losses; 91.8 percent of the sample received some positive income. However, the percentage of farmers with losses varied from year to year, from a high of 20 percent in 1982 to a low of 7 percent in 1984. Most farmers in the sample—93.4 percent—remained in the outgrowers' program. Farmers who had one debit crop usually continued in the scheme and went on to achieve a positive income from sugar.

There was no significant difference in either yield or income between smaller and larger farmers. The results indicate that the net returns per hectare of land and the net returns per family day of labor were positive and stable across the three harvests (Table 10). In addition, the net returns to family labor were significantly higher than the daily wage rate for agricultural labor. This may seem surprising given the volatility in the world price of sugar during the period 1979-84. However, the government of Kenya adopted a protectionist policy with regard to prices paid for sugarcane. Since 1979, there has been a consistent increase in both the nominal and real price paid to smallholders for sugarcane. If the government had used the world price of sugar as a benchmark for establishing the producer cane price, the profitability of sugarcane production in Kenya would be very different. A reanalysis of the data from Table 10

Table 11—Yield and income of sugarcane production, South Nyanza, 1978-84

Yield/Income/ Harvest	Year of Planting[a]						
	1978	1979	1980[b]	1981	1982	1983	1984[b]
				(metric tons)			
Yield per hectare							
Harvest 1	118 (31)	98 (26)	87 (29)	118 (23)	108 (56)	84 (26)	90 (16)
Harvest 2	63 (26)	68 (21)	62 (23)	39 (13)	51 (33)	59 (3)	n.a.
Harvest 3	61 (23)	54 (18)	40 (14)	16 (2)	n.a.	n.a.	n.a.
				(1980 KSh)			
Total net income per hectare							
Harvest 1	2,903 (31)	847 (26)	1,453 (29)	5,422 (23)	4,291 (56)	4,116 (26)	4,483 (16)
Harvest 2	3,105 (26)	3,040 (21)	3,623 (23)	1,961 (13)	2,856 (33)	4,661 (3)	n.a.
Harvest 3	3,673 (23)	4,055 (18)	3,201 (14)	690 (2)	n.a.	n.a.	n.a.
Total net income per day of family labor[c]							
Harvest 1	44 (31)	21 (26)	28 (29)	72 (23)	60 (56)	58 (26)	62 (16)
Harvest 2	46 (26)	46 (21)	52 (23)	34 (13)	44 (33)	64 (3)	n.a.
Harvest 3	53 (23)	57 (18)	48 (14)	20 (2)	n.a.	n.a.	n.a.

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Notes: The number of plots is in parentheses. n.a. means data were not available.

[a] The harvest for the plant crop will be approximately 24 months later and each ratoon crop 18 months thereafter.

[b] 1980 and 1984 were drought years.

[c] This is computed as total net income per hectare divided by 90 labor days.

using the average International Sugar Agreement price for 1979-84 shows that in three out of the five years, net returns to land and labor would have been negative. The current sugarcane pricing policy has worked to the advantage of the sugar producers. Most likely this is a major reason why 93.4 percent of the study plots planted with sugarcane have remained in the outgrowers' program.

Comparative Analysis for Local Maize and Sugarcane

The returns to land and labor for local maize and sugarcane are compared in Table 12. Since the cost data on sugar in the previous section were converted into 1980 figures, all cost information in this section is also presented in 1980 Kenyan shillings. A weighted average of sugar plant and ratoon crops for 1980-86 is compared with the maize crops harvested in 1984 and 1986. The gross margins per hectare for sugarcane

Table 12—Returns to land and household labor for sugar and local maize

	Sugar	Local Maize		
Income/Days	1980-86[a]	Based on 1984 Actual Yield (Drought Year)	Based on 1986 Actual Yield (Nondrought Year)	1982-86[b]
Gross margins per hectare (KSh)	5,040[c]	4,988[d]	6,478[d]	6,040
Number of family days of labor per hectare for 24 months	90	510[d]	362[d]	362
Total net income per hectare per family days of labor (KSh)	56.0	9.8	17.9	16.7

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Notes: The Government of Kenya estimates that one out of every five years is a lower rainfall (drought) year in South Nyanza. 1980 is used as the base year for all cost calculations for sugar and maize. All cost data are in constant shillings rounded to the nearest shilling.

[a] Costs for factory-provided inputs and hired labor have already been deducted from income for this calculation.

[b] The 1982-86 average is based on low maize yields for 1984; 1986 actual yields are used for the other four years.

[c] This is the weighted average of plant and ratoon crops from 1980 to 1986.

[d] Based on the assumption that there are four maize harvests in a two-year period. Labor days are the average of household labor inputs in the long-rain and short-rain seasons.

are slightly higher than those for maize in drought years. However, in 1986, which is considered a normal production year, the returns per hectare of land for maize were higher than those for the sugarcane crop.

However, given that household labor input into sugarcane is significantly lower than that for maize, the net income per day of household labor (KSh 56.0) is dramatically higher for sugarcane. In drought years maize earns KSh 9.8 and in normal rainfall years, KSh 16.7. The returns per day of household labor from sugarcane are substantially above the daily agricultural wage rate of KSh 12.0, whereas returns for maize are slightly above the agricultural wage rate in a normal year but below in a drought year.

In order to capture interyear variation, maize returns are analyzed for the period 1982-86. The government estimates that one out of every five years is a low rainfall or drought year in the project area (Kenya 1982). It is assumed, therefore, that one of these years would be a low production year. Actual yields in 1984 for local maize are used to reflect the effects of adverse climatic conditions. The normal production patterns for the other four years are based on actual production statistics for 1986. Table 12, which also presents the analysis of the gross margins for land and household labor for local maize and sugarcane for the multiyear periods, shows that the returns to land for local maize are superior to those of sugarcane for the multiyear period. However, the returns per day of household labor are still superior for sugarcane, compared with maize, for the multiyear period. The analyses presented in Table 12 are fairly robust: regardless of whether the comparison is made in a normal production year or over a number of years, the returns to household labor for sugarcane are higher than those for local maize by a factor of three to five.

In the project area, labor is more of a constraint to production than land. Presumably, households want to optimize returns per day of household labor. In this respect, sugarcane production is quite attractive.

4

INCOME

Proponents of a strategy advocating the commercialization of agriculture assume that incomes of farmers will increase as they switch all or part of their land to cash crop production. While higher income is only one of a series of household objectives, it is clearly an important one. This chapter examines the effects of sugarcane production on income and expenditure patterns.

Since 1984 was a drought year in Kenya, one would expect that incomes of agricultural households would be lower than in a normal production year. Table 13 provides data on the income per capita for 1984 and 1986 for the cohort sample of households. What is apparent is that not all households were equally affected by the drought.

The comparisons of the baseline versus the follow-up study indicate that the income per capita of all types of households—agricultural and nonagricultural—have increased both in nominal and real terms. However, the magnitude of this increase varies dramatically. The nonsugarcane producers can be used as the reference for the difference in income between a "good" and a "bad" production year. Although yields for the major staple, maize, declined by about 60 percent in the drought year, incomes of the nonsugarcane farmers increased only 13 percent in real terms during the 1986/87 period. This is because the higher maize yields in the 1986 seasons were offset in part by the lower amount of total land put into production in the nondrought year by the nonsugarcane farmers.

With the exception of the merchant group, the biggest jumps in income between the two time periods were for the new entrants and the landless groups. The reasons for this vary.

The average annual income of the new entrants group (KSh 1,956 per capita) was virtually identical to that of the nonsugarcane producers (KSh 1,924 per capita) in the 1984/85 baseline study. In the follow-up study, the annual income per capita (both nominal and real) of the same new entrants group was significantly higher than that of the nonsugar group (Table 13). In the follow-up study, both the new entrants and sugar farmer groups had incomes per capita significantly higher than nonsugarcane producers.

Part of the difference in incomes between the cohort sample of new entrants and nonsugarcane producers is due to differences in marketed agricultural income (Table 14). The new entrants' income per capita of KSh 791 for marketed goods is significantly higher than the KSh 365 per capita for the nonproducers. However, other sources of income also contribute to the difference in incomes between the two types of households. Of the KSh 1,129 difference in nominal income per capita between the new entrants and nonsugar cohort groups in 1986, 41 percent can be attributed to commercial agricultural income, 38 percent to semisubsistence income, and the remaining 21 percent to higher nonfarm incomes in the new entrants group.

Unlike the baseline study, where sugarcane production contributed 73 percent of the difference in incomes between the sugar and nonsugar producers, the higher incomes of the new entrants came from more varied sources in the follow-up study.

Many sugar farmers in the cohort sample entered their second contract during the period between the baseline study and the follow-up study. Their sugarcane plots were

Table 13—Mean nominal and real income per capita, by activity, for the cohort group

Activity Group	Mean Nominal Income per Capita 1984/85	1985/86	Mean Real Income per Capita[a]
		(KSh)	
New entrants	1,956 (42)	3,837 (38)[b]	3,070 (38)[b]
Sugar farmers	2,591[c] (139)	3,390 (135)[d]	2,712 (135)[d]
Nonsugar farmers	1,924 (231)	2,708 (205)[b,d]	2,166 (205)[b,d]
Merchants	2,209 (29)	5,265 (15)[e]	4,212 (15)[e]
Wage earners	2,037 (18)	3,222 (14)	2,578 (14)
Landless	1,290 (43)	2,338 (33)	1,870 (33)
Sample mean for cohort	2,077 (502)	3,091 (440)	2,473 (440)
Relocated	n.a.	2,598 (68)	2,078 (68)

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Note: n.a. is not applicable.

[a] 1985/86 incomes are adjusted to 1984 levels using a GDP deflator derived from World Bank, *World Development Reports, 1986, 1987* (Oxford University Press, 1986 and 1987).

[b] New entrants versus nonsugar farmers ($p < 0.05$).

[c] Sugar farmers have higher incomes than nonsugar and landless groups at the 0.05 level of significance.

[d] Sugar farmers versus nonsugar farmers ($p < 0.05$).

[e] Merchants have significantly higher incomes than all other groups, ($p < 0.05$).

plowed and reseeded, and thus they did not receive another payment for a sugar crop during the second study. This is the main reason for the percentage of income received from commercial agriculture being lower in the cohort sample of sugar farmers than in the baseline study.

Interestingly, the landless group of households was the lowest income group in both studies, yet it had one of the highest increases in real income between the two time periods. The major portion of the income increase for the landless group was from semisubsistence income—that is, production used for own consumption. This is counterintuitive because the term "landless" normally implies that a household has no land. In this case, however, although the landless households do in fact own no land, they have access to public land controlled by the local council. Not only did absolute income increase, but the relative increase in real income was accounted for primarily by the semisubsistence income. The landless were affected by the drought because their access to land was more limited—a half hectare for the entire household—than that of the agricultural households. As already shown in Table 2, the agricultural households, whether sugar or nonsugar producing, use only 44-58 percent of their land for production in a normal agricultural year, whereas the landless use all land possible to produce food. Despite using 100 percent of the land to which they had access for food production, the area per capita cultivated by the landless was 0.08

Table 14—Mean income per capita per year, by source and activity group, cohort sample, 1984/85 and 1985-87

	Agricultural Income				Nonagricultural Income		
	Used for Own Consumption		Marketed				
Activity Group	Mean	Percent	Mean	Percent	Mean	Percent	Sample Size
	(KSh)		(KSh)		(KSh)		
Baseline study							
New entrants	728	37	404	21	824	42	42
Sugar farmers	748	29	942[a]	36	901	35	139
Nonsugar farmers	822	43	393	20	709	37	231
Merchants	51	2	17	1	2,141	97	29
Wage earners	171	8	45	2	1,821	90	18
Landless	163	13	48	4	1,079	83	43
Total sample mean	669	32	482	23	926	45	502
Follow-up study							
New entrants	1,761[b,c]	46	791[b]	21	1,285	33	27
Sugar farmers	1,370[c]	40	625[d]	19	1,395[d]	41	146
Nonsugar farmers	1,302[b]	48	365[b,d]	14	1,041[d]	38	205
Merchants	571	11	49	<1	4,646[e]	88	15
Wage earners	972	39	233	7	2,017	63	14
Landless	841	36	162	7	1,336	57	33
Total sample mean	1,292	42	452	15	1,347	43	440

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

[a] Sugar farmers have higher marketed agricultural income per capita than all other groups at the 0.05 level of significance.

[b] New entrants versus nonsugar farmers ($p < 0.05$).

[c] New entrants versus sugar farmers ($p < 0.05$).

[d] Sugar farmers versus nonsugar farmers ($p < 0.05$).

[e] Merchants have higher nonagricultural income than all other groups at the 0.05 level of significance.

hectare per person, compared with 0.14-0.17 hectare for the agricultural households. The coping strategy used by the agricultural households in the 1984 drought year—putting more land into production—was not possible for the landless. Because they could not put more land into production to compensate for the lower yields of basic staples per acre, the drought affected them more.

Each of the nonagricultural groups received the major portion of its income from nonfarm sources—57 to 88 percent for the cohort sample (Table 14). One group not in the cohort sample—the relocated—are included in the follow-up data in Table 13. The incomes of the households in the relocated group were similar to those of the nonsugarcane producers. The source of this income was, however, different for the two groups. The relocated households obtained a larger proportion of their incomes from nonfarm employment (55 percent) than did the nonsugarcane producers (36 percent). Conversely, the nonsugar producers obtained a greater share of their income (49 percent) from semisubsistence production; only 40 percent of the incomes of the relocated group came from production used for own consumption. Part of this difference in incomes was due to differences in landholdings.

As shown in Table 15, the amount of land owned, on average, by the households that were relocated as a result of the construction of the Sony sugar estate decreased substantially from 5.10 hectares to 1.17 hectares. It is not surprising, therefore, that the proportion of income provided by production used for own consumption was less for relocated households than for nonsugar farmers.

Table 15—Characteristics of relocated households

Item	Amount
Mean hectares owned prior to relocation	5.10
Mean hectares owned after relocation	1.17
Mean amount paid per acre sold (KSh)	894
Mean amount paid per acre bought (KSh)	1,019
Percentage of relocated households now growing sugar	13.3
Percentage of relocated households now landless	13.3

Sources: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

If the relocated households had maintained the same amount of land owned prior to the creation of Sony—5.1 hectares—their average landholdings would have been larger than most of the other agricultural groups. Their household incomes probably would have been higher than they were.

Although for 71 percent of the relocated sample, land was the first item purchased with the money received for the sale of their old land, other items were also bought. Thus, the total amount of money received from the sale of their land was not reinvested in land. Moreover, even if 100 percent of the money received from the sale had been used to purchase new land, less land could have been bought because the price per hectare of land jumped by 20 percent in the community. This is undoubtedly one reason why 91 percent of the relocated sample believe that their life has been worse since the creation of the sugar scheme.[14]

What is clear from the data in Table 14 is how diversified income sources are for each category of household. Even agricultural households depend on nonagricultural sources for 33-41 percent of their total household income.

Expenditure patterns for the cohort sample are given in Tables 16-20. For all types of households, except merchants, the greatest share by far of total expenditures is allocated to food (Table 16). For merchants, expenditures are evenly split between food and nonfood items.

Within agricultural households, whether sugar- or nonsugar-producing, a higher share of food expenditures is accounted for by production used for own consumption (Table 17). Cereals and grains are the major category of food expenditure for each type of household (Table 18). There is little variation in the composition of the diet among different types of agricultural households. Within the cereals and grains category, maize and maize flour account for approximately 36 percent of the expenditures on staples (Table 19).

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[14] Respondents were asked the question, "How has your life changed since the creation of the Sony factory?" Their open-ended responses were coded as better, worse, or about the same.

Table 16—Expenditures by activity group, cohort sample, 1985-87

Activity Group	Total Expenditures	Nonfood Expenditures	Food Expenditures	Food Budget Share
		(KSh/capita/week)		(percent)
New entrants	62.61	11.48	51.13	82
Sugar farmers	52.77	12.06	40.71	77
Nonsugar farmers	49.14	9.59	39.55	80
Merchants	77.21	37.50	39.71	51
Landless	51.99	12.38	39.61	76
Sample mean	52.71	11.74	40.97	78

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Table 17—Share of food purchased versus food produced at home by activity group, cohort sample, 1985-87

Activity Group	Purchased	Own Produced
	(percent)	
New entrants	41.7	58.3
Sugar farmers	41.8	58.2
Nonsugar farmers	39.7	60.3
Merchants	75.0	25.0
Landless	57.5	42.5
Sample mean	43.1	56.9

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Note: Purchased and own-produced food are given as percentages of total food expenditures.

Table 18—Distribution of food expenditures among food groups, by activity group, cohort sample, 1985-87

Activity Group	Cereals and Grains	Roots and Tubers	Meat, Eggs, and Fish	Pulses and Vegetables	Fruits, Snacks, Desserts, and Beverages	Cooking Ingredients and Others
				(percent)		
New entrants	41.3	8.2	16.9	10.4	19.1	4.1
Sugar farmers	44.0	7.5	15.5	10.7	17.7	4.5
Nonsugar farmers	45.2	7.3	16.1	10.3	16.9	4.2
Merchants	37.8	2.1	21.7	10.8	22.1	5.4
Landless	41.7	4.2	19.6	12.0	17.2	5.4
Sample mean	44.0	7.0	16.5	10.6	17.5	4.4

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Note: Numbers may not add to 100 because of rounding.

Table 19—Food expenditures on staples as a percentage of total food expenditures, by activity groups, 1985-87

Staple	New Entrants	Sugar Farmers	Nonsugar Farmers	Merchants	Landless	Sample Mean
			(percent)			
Maize flour	27.1	31.4	32.6	19.5	25.6	30.8
Maize	6.8	5.3	5.5	6.5	5.9	5.6
Millet	0.2	0.1	0.2	0.0	0.1	0.1
Rice	0.9	0.7	0.8	1.7	1.0	0.8
Wheat products	0.6	0.2	0.2	1.1	0.1	0.3
Doughnuts	0.2	0.3	0.3	0.8	0.4	0.4
Bread	1.3	1.5	1.5	5.1	3.6	1.7
Finger millet	1.8	1.0	0.9	0.8	0.6	1.0
Sorghum	0.6	1.4	1.1	0.1	1.2	1.1
Grinder	1.8	2.1	2.1	2.0	2.9	2.1
Cake and biscuits	0.0	0.0	0.0	0.1	0.1	0.0
Others	0.0	0.0	0.0	0.1	0.0	0.0
English potatoes	0.1	0.2	0.1	0.6	0.3	0.2
Sweet potatoes	5.4	4.7	4.4	1.3	2.2	4.3
Cassava	1.1	1.0	1.0	0.2	1.3	1.0
Yams	0.0	0.0	0.0	0.0	0.0	0.0
Cassava flour	1.6	1.6	1.8	0.1	0.4	1.5
All staples as a share of total food expenditures	49.5	51.5	52.5	39.9	45.9	51.0

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Notes: Staples include all cereals, grains, roots, and tubers. Numbers may not add to total due to rounding.

There are, however, differences in nonfood expenditures among the different types of agricultural households. New entrants spend significantly more on education than either sugar or nonsugar farmers (Table 20). In addition, new entrants spend substantially more on transportation than nonsugar farmers. The implications of changes in income and expenditures on food consumption and nutrition for the new entrants will be explored in Chapters 5, 6, and 7.

Table 20—Nonfood expenditures per capita by activity group, 1985-87

Item	New Entrants	Sugar Farmers	Nonsugar Farmers	Merchants	Landless	Sample Mean
			(KSh/capita/week)			
Health	0.17	0.19	0.20	0.55	0.19	0.20
Education	0.66	0.41	0.50	0.50	0.35	0.48
Housing	0.28	0.23	0.21	7.96	0.55	0.52
Clothing	0.79	0.77	0.84	0.55	0.51	0.78
Clothes	0.61	0.65	0.74	0.44	0.44	0.67
Footwear	0.18	0.12	0.10	0.11	0.07	0.11
Transportation	1.58	0.75	0.42	5.04	0.26	0.78
Public transport	1.57	0.72	0.41	5.02	0.26	0.77
Bicycles	0.01	0.03	0.01	0.02	0.00	0.01
Others	8.00	10.18	7.42	22.90	10.52	8.98
Fuel and light	0.36	0.48	0.53	3.13	1.06	0.63
Supplies/household goods	0.72	0.50	0.57	0.43	2.37	0.69
Family event	0.17	0.18	0.14	0.08	0.10	0.15
Land	0.21	0.09	0.02	0.00	0.09	0.07
Livestock	0.13	0.20	0.20	0.26	0.07	0.18
Personal care	1.19	2.17	1.47	6.01	1.14	1.95
Other personal care	0.02	0.03	0.02	0.44	0.03	0.04
Household services	0.32	0.31	0.33	3.90	0.30	0.44
Maintenance	0.11	0.24	0.51	3.10	0.00	0.44
Communications	0.03	0.04	0.01	0.32	0.01	0.03
Recreation and entertainment	0.17	0.08	0.05	0.30	0.06	0.07
Miscellaneous	0.71	1.26	0.62	1.92	1.70	0.96
Farm tools	0.09	0.03	0.04	0.01	0.02	0.04
Liquor	0.29	0.39	0.24	0.01	0.36	0.30
Tobacco and cigarettes	0.18	0.09	[illegible]	0.00	0.34	0.16
Other expenses	3.30	3.14	2.47	2.99	2.86	2.82

Sources: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

5

CALORIC CONSUMPTION OF HOUSEHOLDS AND PRESCHOOLERS

A major objective of this research is to examine the implications of the levels and patterns of income on household food security. Given the differences in income noted in Chapter 4, one would expect sugarcane production to have a positive effect on the caloric intake of households. This chapter looks at the pattern of caloric intake of households and of preschoolers within households.

Table 21 presents the caloric intake per adult equivalent[15] for the cohort sample in both studies. The overall level of intake per adult equivalent is similar for the two time periods—2,657 kilocalories for the baseline study compared with 2,663 for the follow-up study. Thus, the significant increase in yields for most major crops has not led to a concurrent increase in the average caloric intake for the study population largely because intake levels were close to the caloric requirement in both time periods, averaging about 93 to 95 percent for the sample. If households are at or close to "true" requirements, a dramatic increase in caloric requirements is not likely.

In the 1984/85 baseline study, there were no significant differences in caloric intakes per adult equivalents among the various types of households. In the baseline study, caloric intakes of the new entrants (2,822) and the nonsugar-producing households (2,669) were not significantly different. However, the caloric intake for the new entrants group is significantly higher than both the nonsugar and sugar producers in the follow-up study. For the cohort sample, the caloric intake for the new entrants group improved between the baseline and the follow-up study primarily because of a decrease in variation in the level of caloric consumption.

Although the 1984/85 study did not explicitly examine the consumption patterns of the relocated households, given that the majority of the relocated households are nonsugar producers, it was expected that their caloric intake would be the same as the nonsugar group. However, the caloric consumption of the relocated group (2,465 kilocalories) is lower (although not significantly lower) than that of the nonsugar group (see Table 21). This may be partly because the relocated have a significantly smaller number of hectares per capita on which to grow food.

What is more important than average calorie consumption within the different activity groups, however, is the distribution of caloric consumption within the groups. Table 22 looks at the percentage of households falling at or below 80 percent of energy requirements and between 81 and 100 percent of requirements. The proportion of households below 80 percent is of particular concern because, although some adaptation to low or inadequate caloric intakes is possible, it is unlikely that a household could successfully adapt to chronic caloric intakes below 80 percent of standard requirements.

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[15] The following weights were used to calculate adult equivalent units (AEU): 2,850 kilocalories was the requirement for an adult male. Adult males were assigned a weight of 1.0 AEU and adult females 0.8 AEU. Children in the household (defined as those less than 15 years of age) were assigned weights of 0.33 to 0.75 AEUs, depending on age.

Table 21—Household calorie intake in 1984/85 compared with 1985/86, for cohort and total samples

Activity Group	1984/85[a]	1985/86[a]
	(kilocalories/adult equivalent/day)	
New entrants	2,822	2,848[b,c]
Sugar farmers	2,689	2,649[b]
Nonsugar farmers	2,669	2,641[c]
Merchants	2,281	2,462
Wage earners	2,898	2,668
Landless	2,506	2,751
Cohort sample mean	2,657	2,663
Relocated	n.a.	2,465
Sony	n.a.	2,760
Total sample mean	n.a.	2,631

Source: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow up Survey, 1985-87," South Nyanza, Kenya.

Notes: An all-season average is devised for caloric intake per adult equivalent for each study. Sony employees and relocated households were not included in the baseline. n.a. means not applicable.

[a] No two groups are different at the 0.05 level of significance in either study.

[b] The t-test comparison of new entrants and nonsugar farmers indicates $p < 0.05$.

[c] The t-test comparison of new entrants and sugar farmers indicates $p < 0.05$.

One note of caution: the merchant group appears to have an artificially high prevalence of caloric deficiency. This is more likely due to lower energy needs of this group because of sedentary lifestyles than to "true" caloric inadequacy per se.

The proportion of the new entrants sample that falls into this severely restricted group is smaller than that in the nonsugar group for both studies. The new entrants not only have higher household calorie consumption, on average, than the nonsugar

Table 22—Percentage of calorie-deficient households, by activity group, in baseline and follow-up studies

	Baseline Study		Follow-up Study	
Cohort Sample	Households at or Below 80 Percent of Caloric Requirements	Households Meeting 81 to 100 Percent of Caloric Requirements	Households at or Below 80 Percent of Caloric Requirements	Households Meeting 81 to 100 Percent of Caloric Requirements
		(percent)		
New entrants	17.9	33.3	20.0	25.0
Sugar farmers	30.7	24.1	28.1	36.3
Nonsugar farmers	30.0	28.5	28.7	30.1
Merchants	42.1	31.6	41.2	29.4
Wage earners	15.4	30.8	14.3	42.9
Landless	34.3	25.7	26.5	26.5
Cohort sample mean	29.6	27.5	27.6	31.6
Sony	n.a.	n.a.	23.0	37.0
Relocated	n.a.	n.a.	35.0	42.0

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Note: An energy standard of 2,850 kilocalories per adult equivalent unit is used. Sony and relocated households were not included in the baseline study. n.a. indicates not applicable.

households, but the proportion of new entrants falling below 80 percent of the standard is also smaller.

Here again, one might expect data for the relocated group, who are mostly nonsugarcane producers, to be very similar to data for the nonsugar households. However, the relocated group has a higher percentage of households below both 80 percent and 100 percent of requirements. This finding is partly explained in Table 23, which examines the effects of various sources of income on household calorie consumption.

The household consumption function in Table 23 indicates that total household income has a positive and significant effect on household caloric intake; therefore, the gains in income associated with sugarcane production translate, in part, into increases in household caloric intake. At the mean for caloric intake, the income elasticity of demand for calories is 0.15.

Different sources of income have different effects on household caloric intake, and these effects are above and beyond the pure income effect. The percent of nonfarm income has a significant, negative effect on household calorie consumption. Relocated households derive 55 percent of their income from nonfarm income, compared with 36 percent for nonsugarcane-producing households (see Table 14). The negative effect of nonfarm income could account for a 589-calorie difference in intake between the relocated and nonsugar groups.[16]

In addition, income from sugarcane production also has a substantial negative effect on household calorie consumption. This negative effect on consumption largely offsets the positive effects of higher household income. Payment for the sugarcane crop comes in one lump sum. Data from several studies have indicated that lump-sum payments tend to be spent on nonfood expenditures that are typically one-time purchases.[17] Qualitative data from this study indicate that income from sugarcane in South Nyanza tends to be spent on improved housing, school fees, and the acquisition of capital goods.

One major reason that various sources of income have different effects on energy consumption may relate to control of income within the household. Nonfarm income is earned and controlled primarily by men within the household. Sugarcane income is also overwhelmingly treated as men's income. Conversely, much of the agricultural production used for home consumption comes from female-controlled plots. Approximately 60 percent of the plots of land allocated to food crop production is controlled by women within the household. Data in Table 23 indicate that women-controlled income has a significant and positive effect on household food consumption.

Greer and Thorbecke (1986) also found that female-controlled income and income from agricultural production are more likely than other forms of income to be used to enhance household-level food security. The data from the present study also suggest that the impact of female-controlled income on household calorie intake is clearly positive. The data in Table 23 supports one of the early hypotheses of the study that it may not simply be total income but control of income and source of income that are important factors in influencing household-level food security.

One purpose of the study was to examine the link between sugarcane production/household-level food security and the food intake of children. The analysis of the dietary patterns of preschoolers was, however, complicated by two factors. First, many children,

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[16] The figure of 589 calories was arrived at by taking the difference in nonfarm income between the nonsugar and relocated households (19 percent) and multiplying by the regression coefficient of −31 from Table 23.

[17] See von Braun and Kennedy 1986 for a review of some of the literature on this topic.

Table 23—Regression for household caloric consumption

	Total Daily Household Caloric Intake		
Independent Variable	**β**	**t-Statistic**	**Coefficient**
Women's income (percent)	18.6	2.69	0.007
Round 2	−1,139	−2.89	0.037
Round 3	−1,975	−3.59	0.0003
Round 4	−1,824	−3.27	0.0011
Schooling of head of household	−93	−1.7	0.08
Adult equivalent units	2,278	46.1	0.0000
Income per capita	2.2	6.2	0.0000
Income squared	−1.43E−04	−4.2	0.0000
Percent of nonfarm income	−31.4	−2.89	0.004
Relocated households	50	0.08	0.936
Percent of sugar income	−5,974	−2.54	0.011
Constant	−665	−0.67	0.498
R^2	0.62		
Analysis of variance			
Regression	11		
Residual	1,366		
F	204		
Sig F	0.0		

particularly those in the 6- to 12-month category, obtained a substantial amount of their caloric intake from breast milk. Since it was not possible to quantify the caloric contribution of breast milk in this study, children who were receiving any breast milk were eliminated from the dietary analysis.

Second, preschoolers are often fed from a common family dish. In these cases, the mothers or caretakers are unable to quantify the amount of food eaten by the child at a particular meal. Because data for this group of preschoolers is "incomplete," their energy consumption is underestimated. Although the missing data were equally distributed across the different types of households in the study—not biased toward a particular type of household—these preschoolers were also eliminated from the estimate of caloric intake because the data for them were known to be underestimated.

Table 24 presents data on average caloric intakes as a percentage of requirements met for preschoolers in households present in both the baseline and the follow-up studies.[18] In the 1984/85 baseline survey, the percentage of caloric adequacy of children from sugarcane-producing households was significantly higher than intakes of children from the merchant or landless households.

These findings on preschoolers' consumption from the 1984/85 baseline study are in contrast to data for households in the same study. Household caloric intake was similar across groups, but the baseline data on children alone indicated that preschoolers from sugar-producing households do better and in some cases significantly better than children from other types of households.

In the follow-up study, data on preschoolers from the cohort sample indicate that children from both sugar- and nonsugar-producing households come significantly closer to attaining caloric adequacy than do children from wage-earning households.

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[18] A preschooler's caloric intake was obtained from a 24-hour recall of consumption, as reported by the main caretaker of the child.

Table 24—Comparison of preschoolers' caloric adequacy, by household activity group, 1984/85 and 1985-87

Activity Group	Preschoolers with Complete Data Baseline Study—1984/85	 Follow-up Study—1985-87
	(percent of requirements)	
New entrants	64	54
Sugar farmers	69[a]	66[b]
Nonsugar farmers	58	62[b]
Merchants	47	53
Wage earners	49	38[b]
Landless	46	46
Sample mean	60	61

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

[a] The percentage of preschoolers from sugar scheme households who met standards of caloric adequacy was higher at the 0.05 level of significance than those from landless or merchant households.

[b] The percentage of children from sugar and nonsugar scheme households who met standards of caloric adequacy was higher at the 0.05 level of significance than those from wage earner households.

It is curious that even though the new entrants had a higher household caloric intake than the nonsugar households (Table 21), the children of the new entrants did no better, on average, than children from nonsugar households. It is possible that the benefits of higher caloric intakes at the household level are not shared proportionately among different household members.

A caloric consumption function for preschoolers is specified in Table 25. The elasticity of household calories with respect to child calories is 0.15—the same as the income elasticity for household calories. Therefore, even though preschoolers, on average, are more deficient in calories than households as a whole, preschoolers capture the same share of incremental calories.

As the number of meals a child receives increases, the caloric intake of the preschooler improves. This supports the notion that many small children are physically unable to eat large enough portions of bulky foods at one time to provide the calories they need; thus, more frequent meals improve caloric consumption. The implications of preschooler calorie consumption for nutritional status will be discussed further in Chapter 7.

Table 25—Regression of preschoolers' caloric intake

	Log of Preschoolers' Daily Calorie Consumption	
Independent Variable	β	t-Statistic
Birth order	−2.7E−04	−0.13
Round 2	−0.017	−1.20
Round 3	0.02	1.68
Round 4	0.014	0.95
Gender (1 = boy)	0.013	1.26
Ln household calorie consumption	0.15	4.83
Head of household away	8.4E−03	0.42
Meals (numbers)	0.10	14.37
Age (months)	3.7E−03	7.11
Female head of household (1 = yes)	−0.02	−1.00
Percent diarrhea	7.74E−04	2.45
Adult equivalent	−7.3E−03	−4.16
Child's weight (kilograms)	0.021	7.25
Constant	3.80	11.60
R^2	0.20	
Analysis of variance		
Regression	13	
Residual	3,904	
F	74.98	
Sig F	0.0	

6

MORBIDITY PATTERNS OF PRESCHOOLERS AND WOMEN

The sugarcane scheme was targeted to South Nyanza District with the expectation that the economic growth generated by the outgrowers' program would result in improved health and nutritional status, particularly for the vulnerable groups: preschool-aged children and pregnant and lactating women. The 1984/85 baseline study results indicate, however, that the income gains associated with participation in the outgrowers' program did not translate into improvement in the health status of preschoolers and women, at least in the short run. The 1985-87 follow-up study assesses whether, in the longer term, income changes are associated with decreases in morbidity in women and children. It has already been shown that in the cohort sample, the new entrants group attained significantly higher incomes and household energy consumption than the nonsugar farmers. This chapter examines the effects of increased household income and caloric consumption on the morbidity patterns of women and children.

Descriptive Analysis of Morbidity

Table 26 presents data on morbidity patterns for women and preschoolers for all four rounds combined. For the cohort sample, there is no significant difference in the total time ill or the time ill with diarrhea for preschoolers across any of the activity groups. The new entrants' significant gains in income have not translated into a decrease in the average time ill for preschoolers. These results are similar to those in the earlier baseline survey.

The total amount of time ill for preschoolers is similar to that in the 1984/85 baseline study, dispelling the view held by some that in a normal agricultural production year, prevalence of illness will decrease. As will be seen later, the causes of poor health are not related directly to agricultural production.

Table 26—Percentage of time ill, preschoolers and women, by activity group, cohort sample, 1985-87

	Preschoolers			Women	
Activity Group	Total Time Ill	Number of Children	Time Ill with Diarrhea	Total Time Ill	Number of Women
	(percent)		(percent)	(percent)	
New entrants	29.5	85	4.7	24.5	32
Sugar farmers	29.8	428	4.6	23.8	168
Nonsugar farmers	31.2	542	4.0	24.3	220
Merchants	20.8	45	2.0	21.8	16
Wage earners	31.6	30	4.5	31.9	14
Landless	31.6	62	3.8	21.8	31
Sample mean and size	30.3	1,192	4.2	24.1	481

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Note: The time ill is based on an average of all rounds. No two groups are significantly different.

Table 27—Percentage of time ill, preschoolers and women, cohort sample, by per capita income quartile, 1985-87

Per Capita Income Quartile	Preschoolers				Women	
	Total Time Ill	Number of Children	Time Ill with Diarrhea	Number of Children	Total Time Ill	Number of Women
	(percent)		(percent)		(percent)	
1	27.6	399	3.7	403	21.4	170
2	30.6	398	4.8	405	25.6	162
3	31.9	311	3.9	316	26.1	140
4	31.0	388	4.3	391	22.8	159

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Notes: There was no significant difference across income quartiles.

Morbidity patterns for women and preschoolers are analyzed according to income per capita quartiles. There are no significant differences across income quartiles in the total percentage of time ill for either women or preschoolers (Table 27). This again is similar to findings from the 1984/85 baseline study, which indicated that an increase in income was not associated with a decrease in the prevalence of illness. There are also no differences for preschoolers across income quartiles in the total time ill with diarrhea.

Prevalence of all illness in preschoolers is also stratified by age in Table 28, and by nutritional status classification in Table 29. Illness tends to be most pronounced in the 7-24-month-old children; this period corresponds to the time when most children are weaned—typically a time when morbidity escalates. Data in Table 28 suggest that once children survive the weaning period, overall morbidity tends to decrease slightly. Children classified as better nourished according to any of the three measures were sick less frequently, irrespective of differences in income (Table 29).

Morbidity Models

Morbidity models are specified for preschoolers and women. One problem encountered in formulating these models relates to the interrelationship between sickness and nutritional status. Better-nourished children and women are less likely to be sick, and, therefore, individuals who are less likely to be sick, will have better nutritional status. In order to avoid this circularity problem, predicted nutritional status for preschoolers and women is used in the respective morbidity models.[19]

Results for both women and preschoolers indicate that income is not a significant determinant of illness (Table 30). This corroborates the descriptive analyses presented earlier. In addition, health expenditures per capita are not significantly associated with the prevalence of illness in either women or preschoolers. Both of these findings might seem counterintuitive until one looks at the findings more closely. Household income is usually spent on a mix of goods and services, which, at least in the short term, do

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[19] The predictive equation for the preschooler's weight-for-age is given in Chapter 7. The index of women's body mass was predicted using women's age, women's education, household size, landholding per capita, number of wives in the household, and number of children the woman had. Body Mass Index is defined as weight (in kilograms)/height^2 (in meters).

Table 28—Percentage of preschoolers' time ill with any illness, by age of child and activity group, 1985/86

Activity Group	0-6 Months	Sample Size	7-24 Months	Sample Size	25-36 Months	Sample Size	37-48 Months	Sample Size	49-72 Months	Sample Size
	(percent)		(percent)		(percent)		(percent)		(percent)	
New entrants	22.1	18	38.1	29	23.4	23	29.2	17	32.6	27
Sugar farmers	33.1	56	31.7	113	27.8	78	28.0	58	27.7	99
Nonsugar farmers	30.3	82	39.0	130	30.7	103	27.7	107	26.6	128
Merchants	35.3	4	23.8	15	10.9	7	21.8	10	16.3	9
Wage earners	22.6	6	32.1	8	53.2	6	11.3	3	28.8	7
Landless	27.7	10	37.5	15	37.5	9	26.8	15	30.9	13
Sample mean	30.1	176	35.2	312	29.2	226	27.2	210	27.5	285

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Note: These figures represent averages of all four rounds of the survey.

not impart a health benefit to women or children. As discussed in Chapter 4, there is a tendency for the sugarcane-producing households to spend a slightly higher proportion of their income on nonfood expenditures. The effects of these new expenditure patterns will depend on the items purchased. Nonfood expenditures fall into two broad categories: first, those with no expected health or nutritional effects—consumer goods such as jewelry or radios, for example. The second category of expenditures includes those with a potential impact on health, but these can be further subdivided into short-term versus long-term effects. Some expenditures, like money spent for deworming or other preventive health items, might be expected to have an immediate impact that can be observed even in the very short run.

However, as shown in Chapter 4, increased income in households participating in the sugar scheme is spent on items like improved housing and education. While these

Table 29—Percentage of time ill with any illness for preschoolers aged 6 to 72 months, by indicators of nutritional status and income quartile, 1985-87

Income Quartile	Weight-for-Age		Weight-for-Length		Length-for-Age	
	Less than 75 Percent	75 Percent or More	Less than 90 Percent	90 Percent or More	Less than 90 Percent	90 Percent or More
1	36.1 (41)	26.8 (353)	28.1 (57)	28.2 (307)	30.9 (100)	27.0 (267)
2	40.8 (48)	29.1 (349)	35.8 (52)	29.7 (296)	35.2 (74)	29.4 (274)
3	43.1 (29)	31.0 (280)	32.2 (36)	31,3 (229)	36.5 (65)	29.7 (200)
4	40.0 (26)	30.2 (359)	41.0 (33)	31.4 (300)	35.2 (73)	31.6 (260)
Sample mean	39.8 (144)	29.2 (1,341)	33.6 (178)	30.1 (1,132)	34.1 (312)	29.4 (1,001)

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Note: The numbers in parentheses are the number of children in the sample.

Table 30—Regressions for total time ill of preschoolers and women

Selected Independent Variables	Share of Time Ill	
	Preschoolers	Women
Income per capita	4.38E−04 (0.772)	−1.63E−04 (−0.276)
Z-score of predicted weight-for-age	−5.59 (−4.05)	. . .
Predicted body mass index	. . .	−5.79 (−2.03)
Gender (1 = boy)	1.09 (0.552)	. . .
Health expenditures per capita	−3.40E−03 (−0.74)	5.15 (1.28)
Percent of female income	0.04 (1.078)	−0.98 (−0.233)
Household size	−0.47 (−2.615)	−0.85 (−4.32)
Constant	27.56 (4.03)	162.7 (63.3)
R^2	0.057	0.057
Analysis of variance		
Regression	66	65
Residual	450	401
F	4.522	4.83
Sig F	0.0002	0.0003

Notes: The numbers in parentheses are t-statistics. The ellipses indicate a nil or negligible amount.

expenditure categories may produce health benefits in the long run, they are not associated with changes in morbidity patterns in the short run.

Policymakers are particularly concerned about short-run morbidity because the acutely ill have a higher risk of mortality. The Z-score for predicted weight-for-age has a significant, negative association with illness in preschoolers; better-nourished children are less likely to be sick. Similar results are shown for women. Women with a better nutritional status (as measured by a higher body mass index) are significantly less likely to be ill. Women and preschoolers from larger households are ill for shorter periods of time. The larger households in this community tend to be wealthier.

The lack of proof of a relationship between income and morbidity for either women or preschoolers should not be used to argue that income is not important. At least in the short run and possibly in the medium term, planning for income-generating schemes should be coordinated with other health and sanitation initiatives. The complementarities between increased income and an improved health and sanitation environment should be stressed, so that the potential effects of commercial agriculture on overall welfare can be enhanced.

7

NUTRITIONAL STATUS OF PRESCHOOLERS AND WOMEN

The area of Kenya where this research was conducted has the highest birth-to-two-year mortality rate—216 per 1,000—of any part of the country. In other parts of Kenya the comparable mortality rate is 90 deaths per 1,000 live births. There is also a high prevalence of preschooler malnutrition in South Nyanza. For example, 30 percent of preschoolers in South Nyanza district are stunted, compared with a national average of 16 percent for all districts in Kenya. The government hopes that one positive effect of the transition from semisubsistence to commercial agriculture will be an improvement in the general well-being, including an improvement in child health and mortality statistics.

Descriptive Analysis of Preschooler Growth

The Z-scores for length-for-age, weight-for-age, and weight-for-length, averaged for all four rounds, for both the baseline and follow-up study are given in Table 31. These

Table 31—Z-score for length-for-age, weight-for-age, and weight-for-length of children, by activity group, cohort sample only, 1984/85 and 1985-87

	Z-Score: Study 1			Z-Score: Study 2		
Activity Group	Length-for-Age	Weight-for-Age	Weight-for-Length	Length-for-Age	Weight-for-Age	Weight-for-Length
New entrants	−1.46	−1.13	−0.27	−1.74	−1.06	0.005
	(90)	(90)	(90)	(61)	(61)	(61)
Sugar farmers	−1.34	−1.03	−0.22	−1.67	−1.14	−0.15
	(356)	(356)	(356)	(243)	(243)	(241)
Nonsugar farmers	−1.50	−1.17	−0.31	−1.76	−1.10	−0.04
	(556)	(556)	(556)	(349)	(353)	(349)
Merchants	−0.99	−0.86	−0.27	−1.05	−0.89	−0.26
	(62)	(62)	(62)	(29)	(29)	(29)
Wage earners	−1.65	−1.49	−0.59	−1.87	−1.49	−0.51
	(30)	(30)	(30)	(24)	(24)	(24)
Landless	−1.45	−1.06	−0.18	−1.99	−1.36	−0.16
	(77)	(77)	(77)	(40)	(40)	(39)
Sample mean	−1.42	−1.11	−0.28	−1.72	−1.13	−0.10
	(1,171)	(1,171)	(1,171)	(746)	(749)	(743)

Sources: International Food Policy Research Institute (IFPRI), "Survey, 1984/85," South Nyanza, Kenya; and IFPRI, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Notes: The numbers in parentheses are the number of children in each sample. No two groups are significantly different. Standards of the U.S. National Center for Health Statistics are used as the reference median for nutritional status indicators. The z-scores are averages of all four rounds of the survey.

The baseline survey data included children up to six years of age. The same children are of course older in the follow-up study.

data represent the cohort sample of the children up to six years of age who were present for the earlier survey. Each of these children has, of course, aged; in the follow-up survey they range from one through six years. In the baseline study, there were no significant differences in any of the three anthropometric indicators across any of the household groups. This was somewhat surprising given that the incomes of the sugar farmers were approximately 25 percent higher than the nonsugar farmers and new entrants groups. However, the same results emerge from the follow-up study: there are no significant differences in any of the three indicators across any of the households. Although the new entrants now have an income per capita that is 33 percent higher than nonsugar producers, the preschoolers from the new entrants and nonsugar households are, on average, no different with regard to nutritional status.

The results are the same if all children in the second study are compared with children from the first study (Table 32). This group of children is different from that in the first study because new children have been added to the sample as the result of new births, children below six months who now fall in the range of 6-72 months of age, and new children (usually extended family) who have joined the households. Here again, there are no significant differences across any of the groups.

The prevalence of stunting (length-for-age less than 90 percent of the standard), wasting (weight-for-length less than 90 percent), and weight-for-age less than 80 percent in the various types of households are shown in Table 33. There are no significant differences in the prevalence rates for any of the three indicators in preschoolers from agricultural households.

Table 34 shows the prevalence of stunting, wasting, and low weight-for-age for the cohort sample of preschoolers stratified by household income per capita. There is a tendency, although not significant, for preschoolers from the highest-income group to

Table 32—Z-scores for length-for-age, weight-for-age, and weight-for-length of all preschoolers in follow-up study, 1985-87

	Z-Scores: Study 2		
Activity Group	Length-for-Age	Weight-for-Age	Weight-for-Length
New entrants	−1.73 (98)	−1.11 (98)	−0.07 (98)
Sugar farmers	−1.60 (371)	−1.08 (376)	−0.13 (369)
Nonsugar farmers	−1.74 (498)	−1.05 (515)	0.02 (498)
Merchants	−1.25 (42)	−0.88 (42)	−0.08 (42)
Wage earners	−2.04 (28)	−1.51 (28)	−0.42 (28)
Landless	−1.92 (57)	−1.33 (59)	−0.20 (55)
Sample mean	−1.69 (1,094)	−1.09 (1,118)	−0.07 (1,090)

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Notes: No significant differences are found across groups. This table includes new children who were added to the sample in the follow-up survey, as well as children in the cohort sample.

Table 33—Prevalence of stunting, wasting, and low weight-for-age in preschoolers aged 6 to 72 months, by activity group, 1985-87

Income/ Capita Quartile	Length-for-Age Adequacy		Weight-for-Age Adequacy		Weight-for-Length Adequacy	
	Sample Size	Less than 90 Percent	Sample Size	Less than 80 Percent	Sample Size	Less than 90 Percent
		(percent)		(percent)		(percent)
New entrants	25	25.5	25	25.5	13	13.3
Sugar farmers	94	25.3	74	19.7	48	13.0
Nonsugar farmers	128	25.7	124	24.1	70	14.1
Merchants	5	11.9	5	11.9	5	11.9
Wage earners	8	28.6	8	28.6	6	21.4
Landless	16	28.1	18	30.5	10	18.2

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

have less wasting than children in other income quartiles. There are no significant differences across the income quartiles in weight-for-age less than 80 percent or in the rate of stunting, however.

The general conclusion has to be that, on average, increased household income does not bring about a significant improvement in preschoolers' nutritional status that can be detected by descriptive analysis. This issue will need to be explored further using the multivariate analysis.

Descriptive Analyses of the Nutritional Status of Women

Few studies have attempted to assess the effects of agricultural policies on adult women. Typically, studies have concentrated on assessing women's nutritional status only to the extent that this might influence infant or child growth.

In the baseline study, there was no difference in weight in any of the four rounds nor in the all-round average weight for women in any of the groups. The results from the follow-up study using the cohort sample are similar (Table 35). No significant

Table 34—Prevalence of stunting, wasting, and low weight-for-age in preschoolers, cohort sample, by income per capita quartile, 1985-87

Income/ Capita Quartile	Length-for-Age Adequacy		Weight-for-Age Adequacy		Weight-for-Length Adequacy	
	Sample Size	Less than 90 Percent	Sample Size	Less than 80 Percent	Sample Size	Less than 90 Percent
		(percent)		(percent)		(percent)
1	100	27.9	80	22.0	55	15.5
2	75	22.3	80	23.3	49	14.6
3	66	25.1	55	20.2	32	12.2
4	75	23.8	72	22.3	28	8.9

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.

Table 35—Nutritional status of women in the cohort sample, 1985-87

Activity Group	Weight				Weight (All-Round Average)	Body Mass Index (All-Round Average)
	Round 1	Round 2	Round 3	Round 4		
	(kilograms)					
New entrants	56.6 (32)	58.2 (55)	58.4 (47)	59.7 (55)	58.7 (62)	22.1 (58)
Sugar farmers	57.7 (223)	57.6 (303)	58.1 (296)	57.9 (307)	57.9 (375)	22.3 (305)
Nonsugar farmers	57.0 (302)	56.9 (403)	56.8 (384)	57.0 (377)	56.9 (484)	22.2 (390)
Merchants	60.1 (17)	61.7 (21)	63.4 (11)	61.7 (21)	61.6 (28)	22.6 (24)
Wage earners	54.6 (13)	54.5 (13)	54.4 (15)	53.9 (17)	54.3 (17)	21.1 (15)
Landless	55.7 (32)	56.2 (39)	55.8 (38)	56.5 (41)	56.0 (49)	22.3 (44)
Sample mean	57.2 (619)	57.2 (834)	57.4 (797)	57.6 (818)	57.3 (1,015)	22.2 (836)

Source: International Food Policy Research Institute, "Follow-up Survey, 1985-87," South Nyanza, Kenya.
Notes: No two groups are significantly different. Body mass index is defined as weight (in kilograms)/height^2 (in meters). Numbers in parentheses are the number of women in each sample.

differences could be found in weight by round, by average for all rounds, or average body mass index.

Determinants of Preschooler Nutritional Status

Table 36 presents the regressions for Z-scores for preschoolers' length-for-age, weight-for-age, and weight-for-length. The multivariate analyses substantiate much of what appeared in the descriptive analyses.

One robust finding for all three Z-scores is the strong relationship between the baseline Z-score from the earlier study and the anthropometric indicator from the follow-up study. Given that the time span between the baseline period and the end of the follow-up study is two-and-a-half years, one might not expect this effect to be as strong. However, an increase in the length-for-age Z-score of 1.00 in the baseline period is associated with a 0.61 increase in the follow-up length-for-age Z-score. The corresponding values for weight-for-age and weight-for-length are 0.55 and 0.39, respectively. This indicates that children who were doing well in the 1984/85 study have a high probability of doing well in the follow-up period. Conversely, children who were not doing well earlier are highly likely to continue to have less than optimal nutritional status.

These data also give credence to those who believe that faltering growth is a major criterion for identifying children who are at risk for long-term growth problems.

Caloric intake of a preschooler is a significant, positive determinant of the child's length and weight, but not of weight-for-length (wasting). Similarly, the percentage of time ill with diarrhea has a negative effect on length and weight but not on weight-for-length. Finally, in general, as children get older, their Z-scores for length- for-age and weight-for-age tend to improve.

Table 36—Regressions for preschoolers' Z-scores for length-for-age, weight-for-age, and weight-for-length, cohort sample, 1985-87

Independent Variables	Length-for-Age		Weight-for-Age		Weight-for-Length	
	Coefficient	t-Statistic	Coefficient	t-Statistic	Coefficient	t-Statistic
Head of household	−0.134	−0.74	−0.137	−0.99	−0.03	−0.20
Household size	−0.012	−1.51	−4.28E−03	−0.70	1.44E−03	0.22
Gender (1 = boy)	0.090	1.09	0.03	0.40	−0.03	−0.47
Female head of household	−0.211	−1.45	−0.14	−1.29	−0.07	−0.54
Average Z-score, Study 1	0.605	20.67	0.55	20.09	0.39	10.64
Child's calories	2.42E−04	1.96	2.02E−04	2.13	1.10E−04	1.07
Diarrhea	−0.02	−3.36	−0.014	−3.03	−7.09E−03	−1.46
Mother's height	0.026	3.69	7.80E−03	1.46	−6.3E−03	1.09
Area (hectares)	2.98E−03	0.29	0.01	1.36	0.01	1.29
Age (months)	0.025	8.10	0.01	6.21	1.27E−03	0.51
Constant	−5.60	−4.56	−2.03	−2.16		
R^2		0.51		0.49		0.20
Analysis of variance						
Regression	10		10		10	
Residual	512		514		512	
F	53.4		49.3		13.0	
Sig F	0.0		0.0		0.0	

8

CONCLUSIONS AND POLICY IMPLICATIONS

The commercialization of subsistence and semisubsistence agriculture is the cornerstone of economic development in many developing countries. Proponents of strategies advocating an emphasis on cash crops see commercialization as a means of increasing incomes of rural smallholders, providing employment for the landless, and stimulating growth linkages with other segments of the economy. It is also assumed that the resulting economic gains will improve the welfare of small farmers, including the health and well-being of household members.

Critics of programs to accelerate the production of export or cash crops argue that not only have the economic benefits not materialized, but in some cases the transition to commercial agriculture has had a negative influence on health and nutritional status.

This report presents the results of the follow-up survey in 1985-87, which was an extension of the earlier (1984/85) baseline study conducted to evaluate the income and nutritional effects of cash cropping in southwestern Kenya. This body of research was initiated because the government of Kenya was interested in determining the appropriate balance between cash crop and food crop production for domestic consumption. Because of the controversial nature of commercialization, there was some concern that in areas with increased cash cropping, particularly increased sugarcane production, the nutritional status of preschoolers may be deteriorating.

Only a few studies, besides these two, are based on a random sample of farmers in a commercial outgrowers' scheme. In addition, the design of this research is methodologically stronger than most studies of this type because baseline information was available on the new entrants group prior to their entry into the sugarcane outgrowers' scheme. They were then tracked up to and following the time of the first harvest. This allows strong inferences to be made about the actual impact of commercial agriculture.

In addition, this research provides a rare assessment of the range of effects of commercial agriculture on the entire community. One premise of the study is that some of the most dramatic effects of cash cropping occur in households not directly involved in the scheme—the landless and the merchants. Therefore, a sample of nonagricultural as well as agricultural households were included in the surveys.

The follow-up study also includes a random sample of relocated households in which the government is particularly interested. There is currently some discussion in the government about development of new smallholder sugarcane schemes, and information about the effects of such schemes on relocated households may be used to guide future projects.

The results of this study suggest that commercial agriculture has definite positive effects on household income. In the baseline 1984/85 study, incomes per capita of the new entrants and nonsugar producers were virtually identical. In the follow-up of the cohort sample, the average income per capita of the new entrants group was KSh 1,129 higher than that of the nonsugar group. Part of this increment in income per capita is due to differences in commercial agriculture income. The new entrants earned KSh 791 per capita from commercial agriculture (primarily sugarcane), compared with KSh 365 per capita for nonsugar producers. In the earlier study, incomes per capita from commercial agriculture for the new entrants and the nonsugar producers were almost identical—KSh 404 and KSh 393, respectively. The entry into sugarcane production clearly increased incomes.

The data show that the proportion of land sown with food crops is substantially less for new entrants and sugar farmers, compared with nonsugar farmers. Nevertheless, household food security has not been jeopardized because the overall amount of land per capita under cultivation is similar. New entrants and sugar farmers have maintained food production while expanding commercial agricultural production.

The returns to land (gross margins) were superior for sugarcane compared with maize in drought years but not in nondrought years. However, the net returns to household labor were three times higher for sugarcane than for maize.

The superior profitability of sugar to maize per day of household labor is due in large part to the pricing policy pursued by the Kenyan government. The price paid for sugarcane in Kenya is established by the Office of the President, Government of Kenya. Since 1978, the producer price has increased both in nominal and real terms. If the government had used the world price of sugar, the situation would have been different. In three of the five years included in this study, average net income would have been negative if the price paid to outgrowers for cane had been based on world sugar prices. The pricing policy for sugar in Kenya has worked to the advantage of the small producer.

The higher incomes associated with sugarcane production have resulted in increases in caloric intake for households in the new entrant group. In addition, the higher caloric intakes in new entrant households has translated into increases in the caloric intakes of children in those households. However, the amount of additional calories transferred to children has not been large enough to fill the average caloric deficit in children.

Moreover, the increases in income associated with participation in the sugarcane scheme are not found to decrease child morbidity, at least in the short and medium terms captured by these studies. It may seem counterintuitive that very significant increases in income do not translate into a decrease in the prevalence of illness. One needs to be cautious in interpreting these data. There is a tendency for more commercialized households to spend a slightly higher proportion of their income on nonfood expenditures. Both the 1984/85 and 1985-87 studies show that increased income in households participating in the sugarcane scheme is largely spent on items like improved housing and education. Whereas these expenditure categories may produce health benefits in the long term, in the short term they are not associated with changes in morbidity patterns. One could envision a scenario where increased expenditures on education—particularly education of girls—might result in changes in fertility patterns in the longer term, which, in turn, would influence neonatal outcome and ultimately result in improved infant health. Because of the relatively short time frame of both of these studies, linkages of this type could not be identified.

It is worth repeating that at the study site, sanitation and health practices are poor, and infant mortality and malnutrition rates are high. Whereas, in the longer term, increases in income can be expected to bring about an improvement in overall health and welfare, in the short term, it appears that increases in income must be combined with an improvement in the health environment in order to have a significant effect on preschooler morbidity. This is not to argue that income is not important, but rather that in planning agricultural policies and programs, attention should be given simultaneously to health and sanitation conditions in rural areas. The complementarities between increased income and an improved health/sanitation environment should be stressed, so that the potential effects of commercial agriculture schemes on overall welfare can be enhanced.

The morbidity pattern found in preschoolers is the major determinant of child growth. As already discussed, increases in income as a result of the schemes have had a limited effect on decreasing illness in the short term, and thus there has also been little effect on malnutrition because growth and morbidity are closely linked in preschoolers.

Increased household incomes affect preschoolers' growth mainly through the linkages between incomes, caloric intake, and growth. The analysis indicates that increases in income result in improved caloric intake within the household and that a portion of this benefit is passed on to the child. However, even with a doubling of household income, results suggest only a modest increase in a preschooler's caloric consumption. This level of increased intake is not sufficient, on average, to fill the child's caloric deficit. Even in households where more food is available than is needed to meet caloric requirements, preschoolers often fall well below their apparent energy requirements.

The two Kenyan case studies do not address directly the reasons for inadequate preschooler caloric consumption in situations where income and household food supplies seem not to be constrained. However, one explanation is plausible. The area in which the commercial agriculture scheme has been implemented is one where malnutrition is endemic. There may not be an awareness on the part of households that malnutrition is in fact a problem, since their children look like most other children in the community. If primary caretakers do not perceive a nutritional need, then there would be no reason to assume that the children need more food.

A second explanation is also possible. It is very likely that chronically sick preschoolers feel satiated before their "true" caloric needs have been met. It is also not surprising that a parent would assume that a child does not need more food if the child has indicated that he or she has had enough.

Two things happen to older children. First, they are less likely to be sick. This is shown by both the descriptive data and multivariate analyses. Therefore, the adverse effect of illness on appetite is less pronounced in the older children. Second, older children are probably more likely than younger children to ensure that they receive adequate food. For one thing, they are able to help themselves; unlike very young children, they do not depend totally on caretakers.

The sugarcane outgrowers' program, as it has been implemented, has not been associated with increased preschool malnutrition. Therefore, accusations that introduction of a cash cropping scheme is usually associated with a deterioration in nutritional status are not borne out by data from the two Kenyan studies.

Increased household incomes in rural areas, based on agricultural growth that also includes the smallest farmers and the landless, can make a major contribution to the solution of the hunger problem, but it does not in itself provide a complete solution to the problem of preschooler malnutrition.

Many governments and international agencies are putting increased emphasis on income-generating schemes as a way of achieving health and nutrition objectives. While additional income may be a necessary condition, increases in income, by themselves, may not be sufficient to alleviate malnutrition. at least in the short term. Health and sanitation conditions should be improved in tandem with agricultural policies and programs in order to maximize the nutritional effects of income-generating schemes.

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RESEARCH REPORT

79

EFFECTS OF AGRICULTURAL COMMERCIALIZATION ON LAND TENURE, HOUSEHOLD RESOURCE ALLOCATION, AND NUTRITION IN THE PHILIPPINES

Howarth E. Bouis
Lawrence J. Haddad

January 1990

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FOREWORD

Over the past several years IFPRI has undertaken research on the production, consumption, and nutrition effects of agricultural commercialization in The Gambia, Guatemala, Kenya, the Philippines, and Rwanda. While it is widely recognized that the commercialization of agriculture is essential to overall economic development, various rural population groups adapt differently to the process of commercialization, depending on the resources available to them, economic and social conditions, and government policies. Many households benefit in the form of higher incomes; others may suffer a decline in income. A particular concern of policymakers has been the effect of commercialization on nutrition.

The purpose of these studies has been to analyze the process of commercialization in order to identify key factors that determine nutritional outcomes, with the objective of formulating policies to enhance the beneficial effects of commercialization and minimize the harmful effects.

The present report by Howarth E. Bouis and Lawrence J. Haddad presents the findings for the Philippine case study, located in an area on the southern island of Mindanao where a substantial number of households converted lands from corn to sugarcane production after construction of a sugar mill. The main effects of the introduction of export cropping in this area were a significant deterioration in access to land as smallholder corn tenant farms using primarily family labor were consolidated into larger sugar farms using primarily hired labor; an increase in incomes for households that grew sugarcane; a decline in women's participation in own-farm production; and very little improvement in nutritional status as a result of increased incomes from sugarcane production, primarily because of the high levels of preschooler sickness in the sugarcane-growing households.

The difficulty of generalizing as to the varied effects of agricultural commercialization is brought out by a comparison with the case study for Kenya (see IFPRI Research Report 63 by Eileen Kennedy and Bruce Cogill), where farmers also switched from maize to sugarcane production. In that African setting, where land is often relatively abundant and labor scarce compared with many situations in Asia, women increased their participation in own-farm production as sugarcane was introduced. Yet there are important similarities as well. As all of the commercialization studies have confirmed, poor health and sanitation conditions are a serious constraint to the improved nutrition that increases in income might otherwise have made possible.

John W. Mellor

Washington, D.C.
January 1990

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We thank all the staff at the Research Institute for Mindanao Culture, especially the supervisors under the direction of Lourdes Wong. The project was literally in their hands for a year and a half and we learned a lot from them about how a survey should be run. We are indebted to Father Francis Madigan for putting together such a professional staff over so many years of dedicated work at RIMCU.

We are deeply grateful to Azucena Limbo of the Nutrition Foundation of the Philippines, who provided training for collection of our anthropometric and 24-hour food-recall data, no doubt the most difficult portion of our questionnaire to administer and code. Her competence and enthusiasm helped us through some difficult times.

We thank Joel Asentista, head of the Xavier University extension program in Bukidnon, and Roberto Montalvan, president of the Bukidnon planters association, for giving up so much of their personal time to familiarize us with the study area, as well as Father Antonio Ledesma and the graduate students of the Institute for Market Analysis at Xavier University, whose background knowledge of the area and logistical support were essential inputs into our survey work.

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Howarth E. Bouis
Lawrence J. Haddad

1

SUMMARY

The commercialization of agriculture, and in particular export cropping, has often been blamed as a cause of poor nutrition. Critics contend that if the resources used to produce agricultural exports were used instead to produce food for the local economy, the problem of malnutrition in many countries could be significantly reduced, or even eliminated. Proponents argue that by exploiting comparative advantage and generating faster growth for the overall economy, export cropping raises incomes and improves nutrition. In order to identify policy measures that can enhance positive and minimize harmful nutrition effects, IFPRI has undertaken research on the process of agricultural commercialization in five specific country contexts. This research report presents the findings for the Philippine case study.

Approximately 500 corn- and sugar-producing households were surveyed four times at four-month intervals during 1984 and 1985 in one province in Mindanao, Bukidnon, an area primarily engaged in semisubsistence corn production before the establishment of a sugar mill in 1977. The sample included smallholder landowner, tenant, and landless laborer households. Data were collected on landholdings, income sources, expenditure patterns, calorie intakes, and nutritional status.

An initial random sample of households, both far away from the sugar mill (households that did not have the opportunity of switching to sugar because of the high cost of transporting cane to the mill) and near to the mill, indicated a serious deterioration in land tenancy patterns as a result of the introduction of sugar. Whereas landless households accounted for less than 5 percent of households engaged primarily in corn production, nearly 50 percent of households employed in sugar production had no access to land. When households engaged in sugar production were asked to characterize their tenancy status before the introduction of sugar seven years earlier, the pattern of distribution that emerged between owner, share tenant, and landless laborer households was very similar to the present pattern for corn households. Several former corn tenant households had lost access to land when landlords who had decided to grow sugarcane chose to hire labor for the new crop rather than rent out land on a share-of-harvest basis, as had been the custom with corn.

The detailed survey data show that smallholder sugar landowners and renters who kept their land made substantially higher profits per hectare than their corn-household counterparts (an average of US$225 per hectare per year for sugar compared with US$100 for corn) despite the low prevailing world prices for sugar, which to some extent were transmitted to the domestic market. The higher profits for sugar are in part a reflection of the low and declining productivity of corn. The primarily migrant population reported that corn yields, because of declining soil fertility, were about half of what they had been when they first settled their land. Despite this, all sugar households with access to land continued to plant some land to corn and, on average, produced well in excess of their household needs.

On average, about two-thirds of the labor devoted to corn production is provided by the family and one-third is hired. These fractions between family and hired labor are reversed for sugar production. Women contributed 23 percent of the total labor for corn production, but only 11 percent of the total labor for sugar production.

Sugar households had higher incomes on average than corn households, due partly to higher profits from sugar and partly to larger landholdings, although for most households, sources of incomes were highly diversified, with 29 percent of all incomes coming from nonagricultural sources. The income elasticity for food expenditures at the mean for all sample households was estimated to be 0.65, so that food expenditures rose rapidly with income. However, because higher-priced calories were purchased by higher-income households, a doubling of income at mean income levels leads to only an 11 percent increase in calorie intakes at the household level. A substantial portion of the extra calories that were available at higher incomes went to adults, who were already meeting their recommended intakes of calories. Preschool children (once breastfeeding had been stopped) at all income levels consumed well below their recommended calorie intakes.

A strong association exists between income and height-for-age, a long-run measure of nutritional status, for children less than one year old. However, this association between income and height-for-age is weak for preschoolers at four years of age, which means that height-for-age deteriorates (relative to average heights for a reference, well-nourished population) much faster for higher-income children than lower-income children as they grow older. This aggregate pattern is more pronounced for the higher-income sugar households. Preschool children who are four years of age from households without access to land (corn and sugar landless laborer households) are significantly more stunted than children of the same age in households with access to land, reflecting in part the low availability of calories in these landless households, which spend more than three-fourths of their income on food.

Regressions show morbidity to be an important determinant of short-run nutritional status, weight-for-height. There appears to be little association between income and morbidity, although sugar-household children are sick more often than corn-household children, which is consistent with the more rapid deterioration in height-for-age for sugar-household children as they grow older.

Export cropping can significantly raise the incomes of smallholder producers. However, to prevent further consolidation of smallholder farms, the government needs first to make a conscious effort to encourage export cropping by smallholders by providing them with credit and know-how through extension and by actively promoting their access to processing and marketing facilities where necessary. Second, smallholder corn productivity needs to be improved. Both open-pollinated and hybrid varieties are available, but typically only larger landowners in Bukidnon are experimenting with the new corn technologies.

In the area of nutrition policy, providing landless households with access to land appears to be a sufficient condition for limited improvement in preschooler nutritional status. However, for households with access to land, preschooler nutrition does not seem to improve as income increases. Regressions show calorie intakes of preschoolers to be positively and significantly related to their nutritional status. Yet higher-income households choose to purchase nonfood items and higher-priced calories at the margin, while preschoolers continue to consume well below recommended intakes. Surely education has some role to play in convincing parents to adjust food-expenditure behavior and to distribute calories more equitably among household members. Even this, however, may not be sufficient given the high prevalence of preschooler sickness, even among high-income groups. Reducing illness may involve both education and improvement of community-level health and sanitary conditions.

2

RESEARCH OBJECTIVES AND POLICY SETTING

Specialization, development of markets, and trade, which characterize commercialization, are fundamental to economic growth. But how are higher *average* incomes distributed among various economic and social groups as commercialization takes place? Does a higher household income necessarily mean better nutrition for all household members? Because there are so many possible policy variations within the competing paradigms of specialization and self-sufficiency, because economic and social conditions vary so much across countries and regions, and finally because there are inevitably winners and losers in any process of change, it is unfortunately impossible to answer such crucial questions in any definitive way.

In order to provide some guidance for policy formulation in this area, however, what is possible is to study the *process* of commercialization in specific contexts and to identify key factors that appear to lead either to beneficial or detrimental outcomes in terms of nutrition. In designing and carrying out future projects and policies, then, the research goal would be for policymakers to find ways to enhance the beneficial factors, while minimizing the harmful ones.

Toward this end, the International Food Policy Research Institute (IFPRI) has conducted microlevel studies in five countries—The Gambia, Guatemala, Kenya, the Philippines, and Rwanda—in rural areas where farm households have recently undergone a switch from semisubsistence staple food production to production of crops primarily for sale in the market (Kennedy and Cogill 1987; von Braun and Kennedy 1986; von Braun, Puetz, and Webb 1989; von Braun, Hotchkiss, and Immink 1989; von Braun, de Haen, and Blanken forthcoming). This study, which constitutes Phase II of the Philippine Cash Cropping Project, summarizes the findings for the case study undertaken in Bukidnon Province on the southern island of Mindanao in the Philippines, an area primarily engaged in semisubsistence corn production until the establishment of a sugar mill in 1977, which led to a rapid expansion of sugarcane production. Phase I of the project consists of detailed case studies of 10 households in southern Bukidnon (Corpus et al. 1987). Phase III provides an overview of export crop production in Mindanao in the past 15 years and of the economic and political factors that led to this expansion (Lim 1987). These two phases were undertaken in collaboration with the Institute for Market Analysis at Xavier University, under the direction of Father Antonio Ledesma.

The Philippine Policy Setting

The Philippine economic crisis, precipitated in October of 1983 by the inability of the Marcos administration to meet its foreign debt obligations, resulted in a new focus on agriculture as the key sector in economic recovery. Discussion of agricultural policies during the last years of the Marcos regime and through the first year of the Aquino administration (which began in February 1986) centered on ridding the agricultural sector of monopolistic control by close associates of Marcos and on adjusting macroeconomic trade and fiscal policies so as not to be biased against agriculture.

Public attention to agriculture shifted dramatically to the issue of land reform in January of 1987, when several demonstrators for land reform were killed by security forces near the presidential palace. Land reform has since become the political litmus test of the ability of the Aquino administration to provide a better life for the rural poor. The implication is that agriculture is not only expected to generate much of the growth for the economy as a whole (and in the process contribute increased exports to help pay off the burdensome foreign debt), but also to accomplish this in the context of a significant redistribution of wealth through land reform.

The government investment strategy in rural areas is a crucial component in achieving sustained high agricultural growth rates. The term "investments" is used here in a very broad sense to include expenditures for agricultural research and extension as well as expenditures for irrigation, roads, and other physical infrastructure. Technological change is essential for raising agricultural productivity, the sine qua non of high agricultural growth rates where land is a constraint, as is the case in the Philippines. Perhaps because of the understandable desire to get government out of agriculture after the experience of the Marcos years, perhaps because available investment resources are very limited, and perhaps because of a preoccupation with generating short-run increases in exports to keep up with interest payments on the foreign debt, there has been relatively little discussion of the government investment strategy for agriculture.

Much of the growth in Philippine cereal and export crop production in the past decade has occurred in the southern region of Mindanao. Because of its relatively even distribution of rainfall throughout the year, its position outside of the path of typhoons, and its lower population densities, Mindanao is better situated than Luzon for realizing rapid increases in agricultural productivity.

Over the past 15 years rice yields in Mindanao have grown rapidly enough to now surpass average yields in Luzon, although corn is more widely grown than rice. Mindanao has also witnessed a rapid expansion of production of alternative export crops, including bananas, cacao, rubber, palm oil, coffee, and pineapples. Much of this expansion has taken place on large-scale operational units.

Not only will the growth of agriculture in Mindanao determine to a significant extent whether the high expectations for agriculture as a stimulant to economic recovery will be realized, but the policy choices to be made there are a microcosm of those confronting national agricultural policy. Now that a land constraint has been reached in Mindanao, should the government continue to promote the expansion of large-scale export crop production as a means to earn foreign exchange? Alternatively, if distributional objectives are given precedence by encouraging smallholder export crop production, how much growth, if any, would be sacrificed? A third strategy would be to emphasize increased production of rice and corn, which typically have been grown on smaller operational units and may need to be imported in larger and larger quantities in the years ahead (see Bouis 1989). Under any of these three options, what would be the consequences for income levels and the nutritional status of the poor?

Any complete evaluation of these three broad alternatives would require construction of a multisectoral economic model that could determine agricultural supply and demand responses to market-clearing prices, which is well beyond the scope of this study. However, what this report does provide is a detailed household-level and individual-level look at what happened to land tenure patterns, incomes, and nutrition in an area in Mindanao that was primarily engaged in semisubsistence corn production and then switched to export cropping, with the establishment of a sugar mill.

In the Philippines as a whole, over 3 million hectares of corn are harvested each year, about the same area as rice. Yet corn production and consumption patterns at the household level have been studied relatively little, just as Mindanao has been relatively neglected in the socioeconomic literature. Much has been said and written about the decline of the sugar industry in the Philippines in the wake of low world prices, especially with reference to Negros, where most of the nation's sugar is produced. This study provides some hard evidence on net returns to sugar production of smallholder producers and on their nutritional status in a nontraditional sugar-growing area with a more diversified agricultural economy than exists in most of Negros.

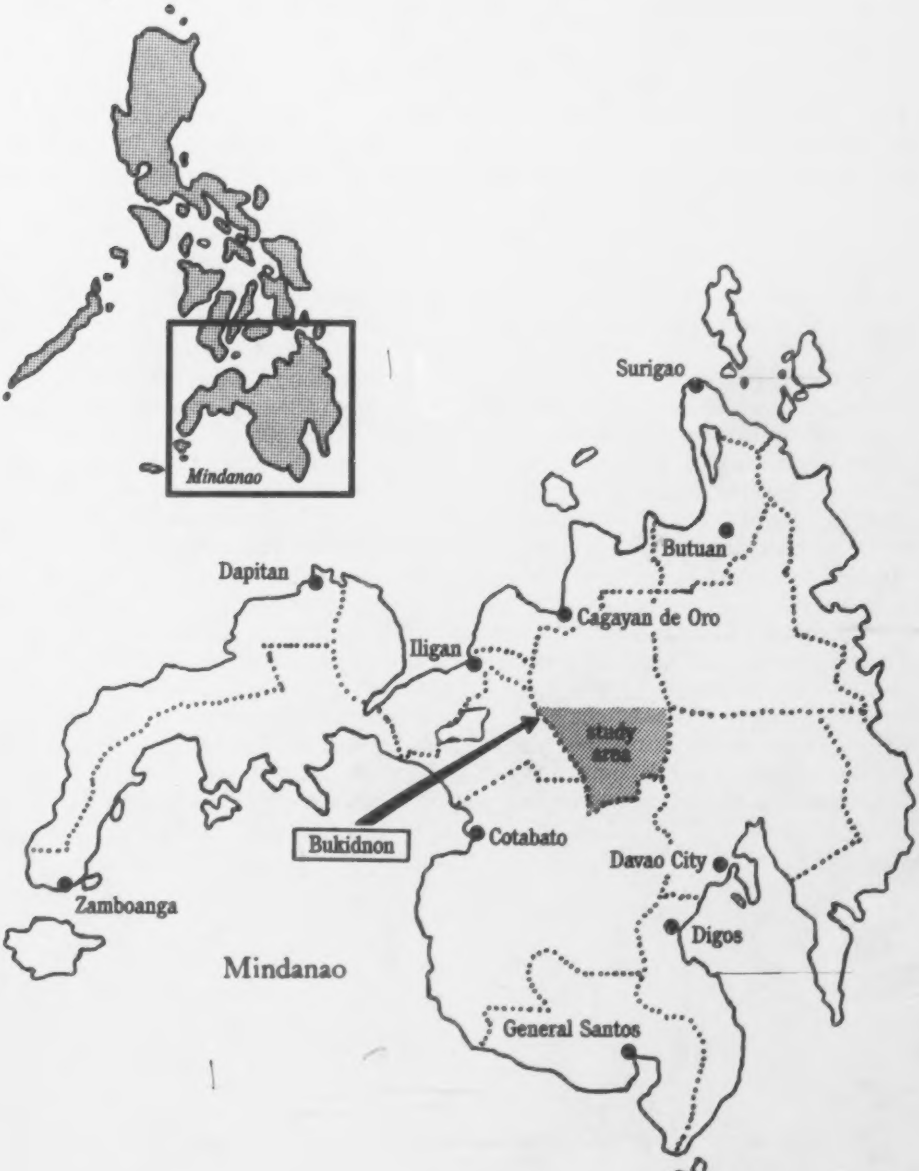
Study Area

The southern part of Bukidnon Province, where the study was conducted, lies about midway between two principal cities of Mindanao, Cagayan de Oro on the northern coast and Davao City on the southern coast (Figure 1). The study area is about a five-hour bus ride from Cagayan de Oro on a partially cemented road that runs through the provincial capital of Malaybalay. It is crisscrossed by a network of unimproved feeder roads, giving most farms relatively easy access to markets for their output.

By the mid-1970s, smallholder agriculture was almost exclusively devoted to corn and some upland rice farming, except for small areas of irrigated rice production. The Bukidnon Sugar Company (BUSCO) began operations in 1977, established in response to the high world sugar prices of a few years before. From the beginning, BUSCO was supplied primarily by sugarcane production from a few large haciendas located near the mill.

Cane production was sufficiently profitable that there was generally a high demand for contracts with the mill, and the mill's capacity was expanded in 1981. Contracts for as little as 1 and 2 hectares were given out. Members of the Sugar Planters Association numbered nearly 2,000 by the time of this survey, dominated by smallholders in absolute numbers but not in area planted or cane produced. Voting power in the association is proportional to contracted hectares and so is dominated by a relatively few large hacienda owners, many of whom also have business interests in the mill.

Figure 1—Map of the Philippines indicating study area


Mindanao
Surigao
Butuan
Dapitan
Cagayan de Oro
Iligan
study area
Bukidnon
Cotabato
Davao City
Zamboanga
Digos
Mindanao
General Santos

3

CONCEPTUAL FRAMEWORK AND RESEARCH DESIGN

After a review of the literature on the nutritional effects of the commercialization of agriculture, two major improvements over previous analyses were incorporated into the research design for the five country case studies noted in Chapter 2. First, it was clear that the optimal strategy would consist of surveying semisubsistence households before and at several intervals after the introduction of a new cash crop. The practical considerations of identifying an area that could be surveyed just before the introduction of a cash crop and the length of time involved in undertaking panel surveys precluded following this optimal strategy. However, an alternative strategy that could be followed consisted of cross-sectional comparisons of two groups—one that had switched to cash cropping and another that had remained in semisubsistence food production. This strategy required that care be taken to choose two groups as similar as possible in terms of resource bases and other factors that might determine the decision to adopt cash cropping and affect nutritional status. All previous studies had either looked only at the nutritional status of a single cash crop adopting group without reference to their nutritional status before adoption or had compared the nutritional status of two groups as suggested above, but groups living under different economic and social conditions.

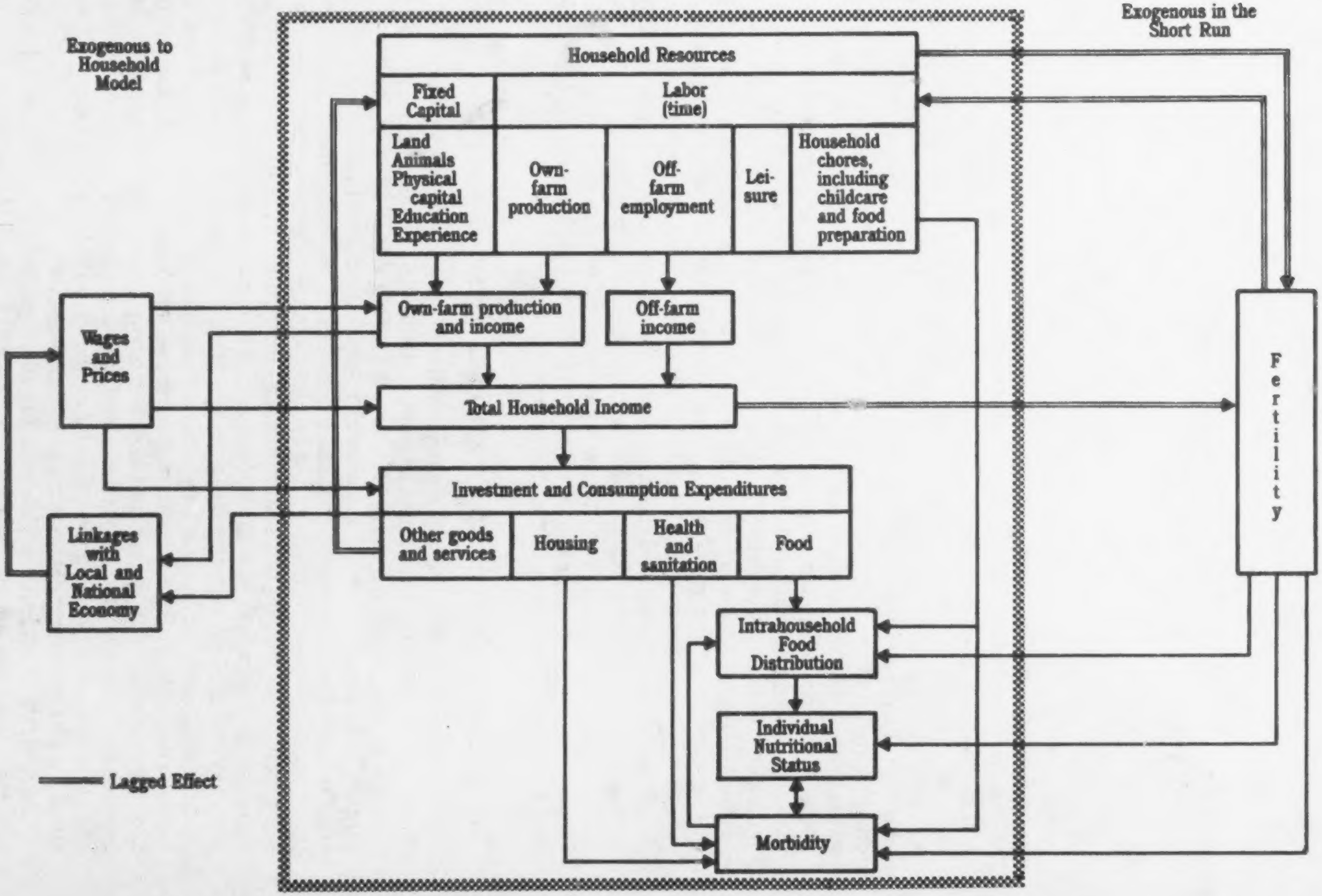
Second, previous studies had looked only at nutritional outcomes without looking at the process that had generated those outcomes, and without identifying the key factors mentioned above that changes in the production system had wrought to either improve or worsen nutrition. Thus, it was necessary to agree upon a conceptual framework for looking at this process at the household level (see Figure 2) before proceeding to collect data for various components of this framework.

The Household Model and Preschooler Nutrition

The theoretical underpinnings for the intuitive diagram in Figure 2 are provided by the literature on the new household economics (Behrman and Deolalikar 1988; Singh, Squire, and Strauss 1986; Pitt and Rosenzweig 1985; Haddad 1987). At the top of the diagram, the household has a fixed amount of time and capital that it must decide to allocate among various income-generating activities, given exogenous prices for consumer goods and production inputs and outputs, with the objective of maximizing well-being from some combination of consumption expenditures, leisure time, and better nutrition. Depending on how those resources are allocated to own-farm production activities and off-farm employment, a certain amount of cash and in-kind income is generated that can then be spent on various consumption items (or consumed). Because the particular interest here is nutritional outcomes, the focus is on food expenditures: how they increase with higher incomes, how many more calories these extra food expenditures generate at the household level, and how these calories are distributed among various household members. Finally, as shown at the bottom of Figure 2, calorie intakes are an important determinant of nutritional status.

However, as is evident from the richness and complexity of the household model, nutrient intakes are not the only link through which household allocation decisions

Figure 2—Household resource allocation and nutrition


Exogenous to Household Model
Exogenous in the Short Run
Household Resources
Fixed Capital
Labor (time)
Land
Animals
Physical capital
Education
Experience
Own-farm production
Off-farm employment
Lei-sure
Household chores, including childcare and food preparation
Wages and Prices
Own-farm production and income
Off-farm income
Total Household Income
Fertility
Linkages with Local and National Economy
Investment and Consumption Expenditures
Other goods and services
Housing
Health and sanitation
Food
Intrahousehold Food Distribution
Individual Nutritional Status
Morbidity
Lagged Effect

affect nutrition. Morbidity is an important determinant of appetite and of how efficiently nutrients are absorbed by the body. The household that earns less income because it allocates more time to food preparation and child care could, conceivably at least, enjoy better nutrition because of reduced morbidity than if it had earned extra income and spent more for food.

Other more indirect links between production and nutrition could be added to the diagram and analyzed. The purpose of this discussion, however, is to limit the focus of research to those links just identified above. The research strategy, then, is to collect detailed household-level and individual-level information on income, production, consumption, time allocation, morbidity, and nutritional status for cash crop adopting and nonadopting household groups, to identify to what extent (if at all, controlling for income) these households allocate their resources differently, and to determine how these allocation decisions affect nutritional status (Bouis et al. 1984).

Estimating Equations

In household modeling, the usual practice is to treat all allocation decisions as simultaneous decisions. Econometrically, this leads to a set of reduced-form equations with endogenous outcomes as dependent variables, and exogenous variables such as prices as explanatory variables. However, this methodology does not permit any conclusions to be drawn as to the specific impact of crucial structural variables in the system at each particular link in Figure 2. Thus, in using this methodology, it is difficult to gain an understanding of the *process* through which nutrition is affected by changes in the production system, and so to identify the key factors that drive that process.

If, however, each step in the household decisionmaking process is not made simultaneously, a way out of this dilemma is provided by specifying the four-equation, recursive system below. At each stage in the system, variables on the right-hand side of each individual equation may be tested for simultaneity with the dependent variable (Hausman 1978). If the null hypothesis of exogeneity is rejected for any equation, an instrumental variables technique may be used to estimate that equation, which should give consistent estimates.

FOOD EXPENDITURES = f_1 (INCOME, Prices, Demographics, Parents' Education) (1)

HOUSEHOLD CALORIES = f_2 (EXPENDITURES, Prices, Demographics, Parents' Education) (2)

PRESCHOOLER CALORIES = f_3 (HOUSEHOLD CALORIES, Demographics, Parents' Education, Parents' Calorie Intakes, Morbidity) (3)

PRESCHOOLER NUTRITIONAL STATUS = f_4 (PRESCHOOLER CALORIES, Morbidity, Demographics, Parents' Education, Father's Height, Mother's Height) (4)

The above formulation is intended to be general. Additional variables to be used in each equation will be discussed more specifically later when the regression estimations are presented. For a detailed discussion of the recursive versus the simultaneous treatment of the model, see Appendix 1.

Sample Selection and Categorization of Households

Conceptually, the research strategy is simply to sample cash crop adopting (sugar) and nonadopting (corn) households, but in the Philippine context the situations of landowners, tenants, and landless laborers need to be compared and contrasted, both within and across crop groups. In selecting a sample, an additional consideration was bias due to adopter self-selection. In the hope of obtaining roughly comparable adopting and nonadopting groups, the survey area was extended beyond the vicinity of the mill to include households that did not have the opportunity to adopt sugar (due to prohibitive costs of transporting the sugarcane to the mill) but shared a common growing environment and cultural heritage with sugar-adopting households.

A short "presurvey" of 2,039 randomly selected households was undertaken, primarily to ask about present and previous occupations, crops being grown, and landholdings. This served two purposes. First, it gave a picture of present employment and land tenure patterns in the survey area and of how these patterns had changed since the sugar mill was built. Second, it provided a frame for choosing a stratified sample of 510 households consisting of landowner, tenant, and landless agricultural labor households within each crop group.

Only households (with at least one child under 60 months of age) that farmed less than 15 hectares were eligible for selection. Only households that characterized the primary occupation (including wage income) of the head of household as either corn or sugar production were eligible for selection (except for a small target group of nonfarm households). Later analysis of the detailed survey data indicated that the respondents' characterizations of their crop and tenure status were quite accurate.

Four detailed surveys were undertaken in these households at four-month intervals, beginning in August of 1984 and ending in August of 1985. Four hundred and forty-eight households remained by the end of round 4. The loss of respondent households was due primarily to out-migration. Table 1 shows the topics covered in each of the four survey rounds.

For purposes of analysis, households were divided into 10 groups. Any household cultivating an average of at least 1 hectare per round of any crop that produced any sugar at all was placed in one of three groups, "sugar owner," "sugar owner/renter (mixed)," or "sugar renter," depending on the proportion of total land cultivated that was owned and rented in. All other households cultivating an average of at least 1 hectare per round were placed in one of four groups, "corn owner," "corn owner/share tenant (mixed)," "corn share tenant," and "corn/other rent," depending on the proportion of total land cultivated that was owned, rented in on a share basis, or rented in on a fixed-rate or other type of arrangement. Typically, land rented for sugar production was rented in on a fixed-rate basis. For corn, the typical rental arrangement was for the tenant to pay a proportional share of the harvest to the landowner. The corn/other rent group includes households that rented in land primarily on a nonproportional basis, usually at a fixed rent.

The households in the remaining three groups, which cultivated less than 1 hectare of land, are characterized as "landless," although this is not strictly true for about half the households in these three groups. If income from nonagricultural sources was greater than agricultural wage income, households were placed in a group designated "other occupation." If agricultural wages were greater than nonagricultural income *and* income from sugar wages was greater than agricultural wages from all other crops, households were designated as "sugar laborer." The remaining "corn laborer" households had sugar wages that were less than half of total agricultural wages.

Table 1—List of topics covered by survey questionnaires, 1984/85

Block	Topic[a]	Explanation
A[b]	General household information	Demographics, education, migration
B	Parcels of land	Ownership, tenure relations
C	Agricultural production record	Steps in production, input use, output
D	Sugar producer's questionnaire	Postharvest processing, disposition of output including revenues from sales, loans, past production history
E	Corn producer's questionnaire	
F	Rice producer's questionnaire	
G	Other crop producer's questionnaire	
H	Agricultural wage labor	By crop, by task
I	Other sources of income	Nonagricultural employment and transfers
J	Backyard production	Livestock, fruits, vegetables
K	Assets (rounds 1 and 4)	Land, buildings, farm implements, consumer durables
L	Past income and assets (rounds 1 and 4)	By employment category; access to land
M[b]	Food expenditures	One-month recall
N	Nonfood expenditures	Four-month recall
O	Source of water and food preparation (round 1)	Primary, secondary; cooking fuel, storage
P[b]	Preschool feeding practices (round 2)	Breastfeeding, weaning practices
Q	Reproductive history (round 1)	Live births, miscarriages, causes of children's death
R	Health services and nutritional knowledge	Doctors, paramedics; based on quiz
S	Time allocation of wife	24-hour recall
T[b]	Anthropometry and morbidity	Measurement, two-week recall
U[b]	Individual food intake	24-hour recall
V	Perceptions of and reactions to technological change (round 4)	By crop; reasons for adoption, nonadoption; input use

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] All topics were covered in each of the four survey rounds unless otherwise indicated.

[b] Accomplished on first visit to households. Remaining blocks were covered during a second visit.

These criteria distributed the sample households so as to avoid cells with low numbers of observations, while taking into account the complexity of the land-tenure relationships that were found. Virtually all "sugar" households produced some corn, except for sugar laborer households that had no land at all.

Table 2 presents selected characteristics that can be compared across the 10 household groupings. The data show that the respondents are primarily a migrant population (typically from the Visayan Islands in the central Philippines). Those who own land tend to be older, to have migrated earlier, to have been married longer, and to have larger families than tenant/renter households. These same relationships hold when comparing tenant/renter households with landless households and, although the data are not shown in Table 2, when comparing large farms with small farms. The level of education is low, with respondents on average just having finished grade school.

As would be expected, incomes and expenditures of owner households are higher than for tenant/renter households and higher for tenant/renter households than for laborer households. At an exchange rate of P20 for US$1, per capita incomes of landless laborer households are roughly US$80 per year, those of corn owner households about US$130, and those of sugar owner households approximately US$195.

In a comparison of like tenure groups across crops, although demographic variables are quite similar, the one exceptional difference is that sugar farms are larger than corn farms. This presents a problem in terms of the research strategy outlined above, wherein it was deemed necessary to sample adopting and nonadopting groups with similar resource bases. If the nutritional status of preschoolers in sugar households is

Table 2—Selected data for respondent households, by crop-tenancy group, 1984/85

Crop-Tenancy Group	Number of Households	Average Age		Percent Born in Bukidnon		Average Years Since Migration to Bukidnon		Average Years of Education		Average Years Married[a]	Average Household Size[a]	Average Area Cultivated per Round[b]	Average per Capita Weekly Expenditure[b,c]	Average per Capita Weekly Income[b,c]	Average per Capita Net Worth[b,c]
		Husband	Wife[a]	Husband	Wife	Husband	Wife[a]	Husband	Wife						
		(years)									(persons)	(hectares)	(pesos)	(pesos)	(pesos)
Corn															
Owners	46	41.4	36.8	0.07	0.13	26	22	6.5	7.0	17	7.7	3.3	49.2	47.7	30,588
Owners/share tenants	44	38.0	34.0	0.11	0.07	25	20	5.8	6.2	15	7.4	3.7	46.6	46.4	18,698
Share tenants	91	34.7	31.3	0.14	0.22	22	19	5.6	6.2	12	6.4	2.0	40.0	28.4	9,744
Laborers	51	33.1	30.0	0.12	0.27	18	17	4.5	5.2	9	5.7	0.3	32.3	26.6	2,135
Sugar															
Owners	41	44.6	38.9	0.02	0.07	26	25	5.3	6.3	20	9.0	6.3	64.4	70.1	62,656
Owners/renters	30	37.4	34.0	0.10	0.03	22	22	6.6	6.8	14	7.1	7.6	89.9	83.3	87,932
Renters	31	37.0	32.3	0.06	0.06	21	20	6.0	6.6	14	7.3	3.0	43.5	43.0	13,079
Laborers	54	32.8	30.2	0.06	0.20	17	18	4.7	5.2	11	6.2	0.2	30.8	26.5	2,201
Corn/other rent[d]	18	34.5	30.6	0.17	0.28	22	20	6.4	7.3	12	5.7	1.9	44.4	35.2	13,324
Other occupation	42	35.6	31.9	0.10	0.26	18	19	6.8	7.2	11	6.0	0.3	43.2	39.1	7,975
Total sample	448	36.6	32.8	0.10	0.17	21	20	5.7	6.3	13	6.8	2.6	45.9	41.5	21,371

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] Responses in round 1, July 1984.

[b] Averages for all four rounds.

[c] Round 1 constant (July 1984) pesos; P20.00 = US$1.00.

[d] Corn growers who rent in land on fixed-rate or other types of arrangements.

better than the nutritional status of children in corn households, is the difference explained by having more access to land or by higher incomes that are possible from sugar production? This turns out not to be a problem, since sugar-household children are not taller and do not weigh more than corn-household children once they reach the age of four. This difference in resource bases only reinforces a conclusion that, while higher income may be a necessary condition for improving the nutritional status of preschoolers, it is not a sufficient condition.

4

CHANGES IN LAND TENURE PATTERNS

The introduction of sugarcane production in Bukidnon apparently led to a significant deterioration in the access to land. This is unfortunate for at least two reasons. First, because access to land is such an important determinant of income in rural areas in a land-constrained, labor-surplus country such as the Philippines (and the survey data to be reported on later bears this out), income distribution has been skewed and the plight of low-income groups has worsened. Second, if a larger proportion of the higher incomes possible from sugar production had gone to lower-income groups instead, the linkages with other sectors of the rural economy would have been stronger, stimulating more local business and service activities, and so generating higher regional employment and economic growth (see Hazell 1983; Johnston and Kilby 1975; Mellor 1976; Ranis and Stewart 1987).

1971 and 1980 Agricultural Censuses

The evidence that the expansion of sugar production has resulted to some extent from a consolidation of smaller operational units comes from three sources: two agricultural censuses conducted by the National Census and Statistics Office in 1971 and 1980 (National Economic and Development Authority 1974, 1985), the presurvey of a random sample of 2,039 households in the study area in 1984, and the four survey rounds. Table 3 shows the distribution of sugar and corn farms, by number of farms, area harvested, and size of farm, for 1971 and 1980 for the whole of Bukidnon Province. In 1971 sugar production was negligible, but it had expanded to more than 9,000 hectares by 1980. Two-thirds of total sugar area was accounted for by farms larger than 25 hectares, which constituted only 12 percent of all sugar farms.

By contrast, corn is a smallholder crop. In 1971 nearly three-fourths of corn farms were less than 5 hectares and accounted for 40 percent of all corn area. Between 1971 and 1980, corn area harvested increased by 51 percent and the number of corn farms by 68 percent, implying (assuming no change in the cropping intensity) a modest reduction in average corn-farm size and a rapid expansion of population. By 1980 nearly 50 percent of corn area was on farms of less than 5 hectares.

While these figures strongly suggest that smallholders participated only marginally in the sugar expansion, it is not clear to what extent the expansion resulted from a consolidation of smaller farms, if at all, or from the decision by large landowners to convert to sugar production lands that they already owned and were either cultivating themselves or leaving fallow. The census data show that there was apparently some expansion of total cropped area onto previously unused land during the 1970s. Unfortunately, the analysis that can be undertaken with the census is limited because data on operational farm size are not disaggregated by type of tenure; the census data refer to the entire province of Bukidnon, while the surveys focus on the southern half of the province; and the census data cover only the period up to 1980 before the expansion of the sugar mill's capacity. The presurvey of 1984 offers more precise evidence.

Table 3—Percentage distribution of sugar and corn farms and area harvested in Bukidnon Province, by farm size, 1971 and 1980

Crop/ Year	Size of Farm: Less Than 1.00 Hectare	1.00-2.99 Hectares	3.00-4.99 Hectares	5.00-10.00 Hectares	10.00-24.00 Hectares	More Than 25.00 Hectares	Total Percent	Total Absolute Number
				(percent of all farms)				(farms)
Sugar								
1971	. . .	. . .	. . .	. . .	. . .	. . .	. . .	21
1980	1.3	14.9	15.0	32.5	24.6	11.7	100.0	951
Corn								
1971	2.8	41.1	29.7	18.8	6.9	0.6	100.0	37,620
1980	4.9	41.1	22.5	23.9	6.8	0.8	100.0	63,239
				(percent of total area harvested)				(hectares)
Sugar								
1971	. . .	. . .	. . .	. . .	. . .	. . .	. . .	320
1980	0.1	2.3	2.6	10.0	17.0	68.1	100.0	9,365
Corn								
1971	0.3	16.1	24.4	28.2	21.8	9.2	100.0	162,607
1980	1.1	25.1	22.9	31.0	14.1	5.8	100.0	244,943

Sources: National Economic and Development Authority, *1971 Census of Agriculture* (Manila: NEDA, National Census and Statistics Office, 1974); and NEDA, *1980 Census of Agriculture* (Manila: National Census and Statistics Office, 1985).

Note: Parts may not add to totals because of rounding.

Presurvey of 2,039 Households

Table 4 presents the distribution of primary occupations of the heads of household recorded from the presurvey. Eighty percent of the respondents identified themselves as either landowners, tenants, or agricultural laborers. About 79 percent of these respondents directly employed in agriculture were engaged in corn production, while only 7 percent were primarily employed in sugar production. Laborer households accounted for less than 5 percent of households primarily engaged in corn or rice production, with the percentage of landowners and of tenants about equal for each of these cereals. Among sugar producers, laborers accounted for nearly half of the households, with a much lower percentage frequency for tenants and a somewhat lower percentage frequency for landowners compared with corn and rice producers. The implication is that if the same distribution of corn landowners, tenants, and laborers existed before the introduction of sugar as now, some former corn landowners, but especially former corn tenants, must have become sugar laborers.

Table 5, which presents data for the previous occupations of heads of households presently engaged in sugar production, shows that this is indeed the case. For a majority of households, land tenure status has not changed. However, 40 percent (21 out of 52) of households presently identified as sugar laborer households were corn owner or corn tenant households before the BUSCO sugar mill was built. Another 40 percent (22 out of 52) in-migrated to the area after BUSCO began operations (typically sugar laborers from the islands of Negros and Panay, who were recruited by the sugar hacienda owners). Thus only about 15 percent of present sugar laborers (8 out of 52) came from the preexisting pool of corn laborers.

Table 4—Present primary occupation of heads of households, all municipalities, April 1984

Occupation	Number of Household Heads	Percent of Household Heads	Percent of Total for Each Crop
Direct agricultural employment			
Corn	1,281	62.8	100.0
Landowner	670	32.9	52.3
Tenant	572	28.1	44.7
Laborer	39	1.9	3.0
Sugar	116	5.7	100.0
Landowner	44	2.3	37.9
Tenant	16	0.8	13.8
Laborer	56	2.7	48.3
Rice	171	8.4	100.0
Landowner	92	4.5	53.8
Tenant	71	3.5	41.5
Laborer	8	0.4	4.7
Other crop	59	2.9	100.0
Landowner	38	1.9	64.4
Tenant	8	0.4	13.6
Laborer	13	0.6	22.0
Subtotal	1,627	79.8	. . .
Transportation-related jobs	94	4.6	. . .
Skilled workers	62	3.0	. . .
Unskilled workers	46	2.3	. . .
Small business/trading	76	3.7	. . .
Other (professional, executive, police, technician, service, typist, clerk, jobless)—	134	6.6	. . .
Total	2,039	100.0	. . .

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture presurvey of randomly selected households in southern Bukidnon Province.

Note: Parts may not add to totals because of rounding.

Except for the in-migrants, almost all households that switched to sugar production had previously been involved in corn production. It is especially important to note that the *previous* tenure distribution of those who switched from corn to sugar production is very similar to the *present* tenure distribution of households primarily engaged in corn production.

Evidence from the Four Survey Rounds

In round 4 of the survey, respondents were asked detailed questions about changes in their tenure status since the establishment of the BUSCO sugar mill. Table 6 is constructed from these responses. All 448 of the round 4 households are included in Table 6, not only households presently engaged primarily in sugar production as in Table 5. For purposes of comparison with Table 5, the tenure categories used are those attributed by the households to themselves, not the categorizations used later in the report that are based on reported landholdings and sources of income.

Table 6 divides the respondents into four employment categories: those primarily engaged in corn production; those primarily engaged in sugar production; those primar-

Table 5—Sugar-producing households, by land tenure and previous occupation, April 1984

Previous Occupation in Agriculture	Present Occupation in Sugar Production											
	Three Municipalities Closest to BUSCO[a]				Seven Municipalities Farthest from BUSCO[a]				All Municipalities			
	Landowner	Tenant	Laborer	Total	Landowner	Tenant	Laborer	Total	Landowner	Tenant	Laborer	Total
Corn landowner	26	2	5	33	9	0	2	11	35	2	7	44
Corn tenant	2	10	8	20	0	3	6	9	2	13	14	29
Corn laborer	0	0	6	6	0	0	2	2	0	0	8	8
Rice landowner	1	0	0	1	1	0	0	1	2	0	0	2
Rice tenant	0	1	1	2	0	0	0	0	0	1	1	2
Rice laborer	0	0	0	0	0	0	0	0	0	0	0	0
Other crop landowner	1	0	0	1	2	0	0	2	3	0	0	3
Other crop tenant	0	0	0	0	0	0	0	0	0	0	0	0
Other crop laborer	0	0	10	10	0	0	12	12	0	0	22	22
Total	30	13	30	73	12	3	22	37	42	16	52	110

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture presurvey of households in southern Bukidnon Province, April 1984.

[a] Bukidnon Sugar Company, which began operation of a sugar mill in 1977.

Table 6—Household employment and land tenure status during round 4 of survey and before sugar mill operation, July 1985

	Present Status			
Previous Status[a]	**Owner**	**Tenant**	**Laborer**	**Total**
	Households Engaged Primarily in Corn Production			
Owner	55	5	0	60
Share tenant/renter	21	98	3	122
Laborer	2	2	5	9
Nonagricultural employment	1	0	0	1
New household[b]	11	44	8	63
Total	90	149	16	255
	Households Engaged Primarily in Sugar Production			
Owner	25	0	1	26
Share tenant/renter	3	8	7	18
Laborer	0	1	11	12
Nonagricultural employment	0	0	0	0
New household[b]	0	4	17	21
Total	28	13	36	77
	Households Engaged Primarily in Agricultural Production (No Crop Specified)			
Owner	36	2	2	40
Share tenant/renter	6	14	0	20
Laborer	0	2	6	8
Nonagricultural employment	0	0	0	0
New household[b]	4	4	4	12
Total	46	22	12	80
	Households Engaged Primarily in a Nonagricultural Occupation			
Owner	. . .	. . .	. . .	4
Share tenant/renter	. . .	. . .	. . .	10
Laborer	. . .	. . .	. . .	1
Nonagricultural employment	. . .	. . .	. . .	12
New household[b]	. . .	. . .	. . .	9
Total	. . .	. . .	. . .	36

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] Employment or land tenure status before the Bukidnon Sugar Company (BUSCO) mill began operations in 1977.

[b] In-migrants to area after BUSCO sugar mill was built.

ily engaged in agricultural production, but who declined to specify a particular crop as dominant; and those primarily engaged in nonagricultural employment. Comparing Tables 5 and 6, note that the percentage of present sugar laborers (who specified a tenure status as a corn producer when BUSCO was established) who lost access to land is nearly equal between the two tables (21 out of 52 in Table 5 and 8 out of 19 in Table 6). The percentages are also similar for present sugar landowners (2 out of 42 in Table 5 and 3 out of 28 in Table 6) and for present sugar renters (–2 out of 16 for Table 5 and 1 out of 9 for Table 6) who bettered their past tenure status.

Table 6 shows that 56 out of 64 households that became involved in corn production *after* the establishment of BUSCO were able to acquire access to land, so the overall tenure pattern remained stable over time (many older residents improved their status from tenant to landowner, while newly married or newly resident couples embarked on corn production in disproportionate numbers as tenants). For households primarily engaged in sugar production, however, only 4 out of 21 newly married or newly resident households got access to land, and none as landowners.

A high percentage of households presently engaged primarily in nonagricultural employment who were married Bukidnon residents when BUSCO was established (14 out of 27) had lost access to land. Only one household moved in the other direction, from nonagricultural employment to corn production. The survey data, then, also present a contrasting picture between sugarcane and corn production of relatively easy access to land for corn production and of a decline in access to land as sugarcane is adopted.

From Table 6, it is possible to identify 38 households whose tenancy status improved, 34 households whose tenancy worsened, and 236 households (with previous access to land) whose tenancy status remained the same. Sixty-seven newly in-migrant or newly formed households gained access to land. The remaining 73 households (including both old residents and new households) have never acquired access to land.

Analysis of the survey data by change in tenancy status shows that for households engaged in corn production the sizes of farms being converted to and taken out of corn production appear to be in rough equilibrium. The average area cultivated by households whose tenancy status was unchanged at 2.5 hectares is almost equal to the average area lost of the 25 households that reported a decline in tenancy status at 2.4 hectares and to the average 2.8 hectares cultivated by the 26 households whose tenancy status improved. The size of the average corn farm appears, however, to have been decreasing over time, as the farms of new households at 1.6 hectares are disproportionately tenant households, which tend to be smaller than owner corn farms.

The dynamics of change in farm size for sugar production appear to be quite different. The average area cultivated by adopting households was about 5.5 hectares—more than twice the area cultivated by the average corn household. The average area lost by households whose tenancy status declined and whose land was converted to sugar production was only a third that size at 1.8 hectares.

Finally, in each month in which wages from sugar production were earned, respondents were asked to identify a farm-size category in which this labor was performed, ranging from a score of 1 for farms larger than 50 hectares to a score of 5 for farms smaller than 5 hectares. An average score of about 4 was reported by the respondents, indicating that most of the off-farm sugar labor provided by our respondent households was hired in by farms of medium size relative to all farms, though small relative to those farms engaged primarily in sugar production.

Did sugar expansion occur on previously unused land? Certainly whatever expansion onto previously fallow land occurred on the largest sugar haciendas contributed little to the employment of local residents, who tended to be hired instead by relatively small sugar farmers.

Eighty of the sugar households who grew sugar during the survey (and had previous access to land) and whose tenancy status remained the same reported that in 1977 they grew mostly corn and that only about 10 percent of their land was left fallow, a percentage similar to that surveyed during 1984-85. Over the same period, these 80 households reported a 28 percent increase in the amount of land that they cultivated, an absolute increase of 1.3 hectares from 4.6 hectares in 1977. The farms of smallholder sugar adopters (small relative to all sugar adopters, large relative to the average corn-producing farm) increased in size as sugarcane *replaced* corn production. The evidence from households with access to land, then, supports a conclusion that there was some consolidation of existing operational farm units.

Conclusion

As already pointed out, land reform is central to the agricultural policy debate presently taking place in the Philippines. In the context studied here, a kind of land reform in reverse has taken place with the introduction of export cropping. This raises at least two important questions. The first is the empirical question (which is beyond the scope of the present study) of whether a similar deterioration in access to land has been occurring all over Mindanao, where various other export crops have been newly introduced.

Second, what are the forces driving this redistribution of land? The analysis that follows will show that these forces appear to be the declining productivity of corn lands, and the know-how and financial resources of the wealthier families, who are in a position to take advantage of a new income-earning opportunity.

5

COMPARISON OF THE CORN AND SUGAR PRODUCTION SYSTEMS

This chapter compares the relative profitability of corn and sugar production. An additional objective is to disaggregate total labor inputs, not only by hired and family labor, but also by labor performed by men, women, and children, in order to gain possible insights into changes in intrahousehold time allocation patterns that might be the result of a switch to sugar production.

The Corn Production System

During the postwar period up until the early 1970s, Bukidnon was a region of heavy in-migration. New settlers typically homesteaded recently cleared rain forest. Conversations with persons who migrated to Bukidnon before 1970 about past corn yields and agricultural wage rates invariably indicated a significantly declining trend in corn yields due to loss in soil fertility, and lower shares of harvest paid to hired laborers over time. An attempt was made to measure these two trends in the detailed household surveys.

According to the respondents, corn yields have fallen dramatically over the past two decades—more than 50 percent in an average of 13 years (Table 7). Similarly, shares paid to harvesters have declined significantly, from one sack in every five harvested in the mid-1960s to one sack in every eight by the time of the survey. The indicated trends, then, are very pessimistic: declining productivity and increasing land pressure.

Peak corn harvests occurred in July and December. The average growing cycle from plowing to harvest was 3.3 months, so there is ample time to grow three crops a year. However, producing a third crop depends on rainfall at the onset of the relatively dry months from March to May. Most of the respondents were able to produce two crops a year. A few households produced three crops. Average yields were highest for the first crop, an average of 0.9 metric ton of shelled corn per hectare.[1] Yields fell by 25 percent for the second crop.

The average labor input per hectare per crop was 51 days. About two-thirds of this labor input is provided by family labor and one-third by hired labor. There is a stronger tendency for the family labor input per hectare to increase as farm size decreases than for hired labor to decrease with farm size. Consequently, labor inputs per hectare are somewhat higher on small farms.

Tractors are used only on the largest farms, and these only sparingly. Land preparation (plowing, harrowing, furrowing) accounts for about 20 percent of total labor use, weeding (with carabao, by hand, or with sickle) almost 50 percent, harvesting about 20 percent, and planting and fertilizing the remaining 10 percent. The only striking differences in labor inputs across household groups within particular tasks occur for weeding by hand and weeding with a carabao, where there is an obvious possibility of substitution between the two types of inputs. There is some tendency for

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[1] All tons in this report are metric tons.

Table 7—Comparison of past and present corn yields, by crop-tenancy group and farm size, 1984/85

Crop-Tenancy Group[a]	Sample Size	Average Hectares Cultivated per Round During Survey	Average Time Land Has Been Planted to Corn	Yield of Shelled Corn: Average Yield in First Few Years	Yield of Shelled Corn: Average Yield, 1984/85 Survey
			(years)	(50-kilogram sacks)	
Corn					
Owners	46	3.3	18.3	37.9	14.2
Large	32	4.1	19.0	40.0	14.5
Small	14	1.3	16.9	33.6	13.6
Owners/share tenants	44	3.7	11.3	32.7	16.8
Large	32	4.6	11.2	33.0	17.5
Small	12	1.5	11.3	30.8	15.1
Share tenants	91	2.0	11.2	35.6	14.9
Large	43	2.9	11.2	34.4	15.1
Small	48	1.2	11.3	36.8	14.8
Laborers	51	0.3	11.0	34.4	11.7
Land	32	0.5	. . .	. . .	. . .
No land	19	0.0	. . .	. . .	. . .
Sugar					
Owners	41	6.3	17.2	41.6	18.2
Owners/renters	30	7.6	13.1	31.8	22.5
Renters	31	3.0	13.1	40.0	18.0
Large	20	3.9	. . .	. . .	. . .
Small	11	1.2	. . .	. . .	. . .
Laborers	54	0.2	9.6	32.9	14.1
Land	26	0.4	. . .	. . .	. . .
No land	28	0.0	. . .	. . .	. . .
Corn/other rent[b]	18	1.9	6.3	25.4	15.3
Other occupation	42	0.3	11.6	31.7	14.4
Total sample	448	2.6	12.9	35.4	15.7

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] A "large" farm is any farm where more than an average of 2 hectares per round was cultivated.

[b] Corn growers who rent in land on fixed-rate or other types of arrangements.

smaller farms to weed more by hand, which accounts for the higher total family labor inputs just noted for smaller farms.

Table 8 shows that of the 32.6 days of family labor inputs per hectare for the total sample, about 15 percent are provided by women (typically the wife) and 25 percent by children. In the hired labor market, participation of children is very low. Women provide a quarter of hired labor inputs.

It is instructive to break down these participation rates by task. The basic pattern is for men to do almost all of the work for tasks associated with use of a carabao. The remaining tasks are shared by husband, wife, and (to the extent applicable) several children.

Fertilizer use is very low. An average of 5 kilograms of nitrogen per hectare per crop was applied. Even the heaviest-user groups (the sugar owner and sugar owner/renter households) applied only about twice the average amount of nitrogen. This is consistent with the low adoption rates of fertilizer-responsive technologies. Only 10 percent of the respondents reported planting improved varieties.

For all tasks except harvesting, the average wage rate received was around 17 pesos (P) per day (US$0.85). Harvesting received a substantially higher wage, about P28 per day. No notable differences were found across the crop, tenure, and size groups in the wages they paid to labor, or in prices they paid for various nonlabor inputs.

Table 8—Total labor inputs per corn crop, by family and hired labor, crop-tenancy group, and farm size, 1984/85

	Family Labor			Hired Labor		
Crop-Tenancy Group[a]	Men	Women	Children	Men	Women	Children
			(person-days/hectare)			
Corn						
Owners	19.8	4.3	5.6	16.9	5.2	1.3
Large	18.5	4.9	6.0	17.9	5.4	1.1
Small	22.9	2.9	4.9	14.3	4.8	1.7
Owners/share tenants	18.7	5.1	6.5	10.4	3.6	0.8
Large	15.3	5.1	4.3	11.7	3.8	0.7
Small	27.3	5.2	12.0	7.2	3.1	0.9
Share tenants	19.4	4.2	7.9	10.0	4.7	1.2
Large	16.9	3.5	9.1	9.1	4.8	1.2
Small	21.9	4.8	6.8	10.8	4.7	1.2
Laborers	24.7	10.3	11.3	6.0	3.3	0.3
Sugar						
Owners	15.7	2.7	11.7	12.8	5.0	1.5
Owners/renters	11.8	2.9	6.2	19.6	5.9	0.8
Renters	18.8	5.0	15.0	13.5	7.2	0.8
Laborers	20.5	6.9	16.5	9.0	2.3	2.5
Corn/other rent[b]	17.7	5.5	4.1	17.7	6.3	0.9
Other occupation	24.3	10.5	2.4	16.4	8.3	1.8
Total sample	19.1	5.2	8.3	12.5	4.9	1.1

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] A "large" farm is any farm where more than an average of 2 hectares per round was cultivated.

[b] Corn growers who rent in land on fixed-rate or other types of arrangements.

The average production cost per hectare was P650. Of this, about two-thirds was paid in cash and one-third in kind (mostly harvest wages, but in-kind payments also included meals for hired laborers engaged in other tasks). Wages (cash plus in-kind) accounted for about two-thirds of total expenses.

Per hectare in-kind wage payments did not vary a great deal across groups and farm sizes, so cash expenditures accounted for most of the differences across groups in total costs per hectare. Corn laborer and sugar laborer groups spent an average of less than P200 cash per hectare per crop. Sugar households (apart from the laborer group) invested the largest amounts of cash, an average of P600 per hectare per crop.

All sugar households continued to produce some corn. Per capita consumption of own-produced corn in sugar households (about 1.3 kilograms per capita per week) was much lower than in corn households (about 2.0 kilograms per capita per week), although sugar households produced sufficient corn to have consumption levels equal to those of corn households (Table 9). Sugar households preferred to purchase more rice in the market instead. For corn households, per capita consumption of home-produced corn on small farms was only marginally lower than on large farms, suggesting that households kept what they needed for home consumption and sold the remainder.

Labor for postharvest shelling, drying, and transport of corn for marketing or for milling into grits was provided primarily by the family and added an average of 3.5 days of total labor inputs per hectare. Analysis of marketing margins between farmgate and retail prices of corn and costs of having shelled corn milled into grits indicates that farmers who grow corn for own consumption save a premium of 25 percent (less storage losses and interest costs) compared with selling their output and buying corn grits in the retail market.

Table 9—Shelled corn production and consumption of own production, by crop-tenancy group and farm size, 1984/85

Crop-Tenancy Group[a]	Production	Production Net of In-Kind Cost	Consumption Out of Own Production	Share of Net Production Sold
		(kilograms/week/capita)		(percent)
Corn				
Owners	7.0	6.0	2.2	64
Large	8.1	7.1	2.4	67
Small	4.4	3.6	1.9	49
Owners/share tenants	10.7	8.6	1.9	77
Large	13.2	10.7	1.9	80
Small	3.9	2.8	1.8	36
Share tenants	8.4	4.9	1.9	63
Large	10.2	6.0	2.1	69
Small	6.9	4.0	1.8	49
Laborers	1.3	0.9	0.5	34
Sugar				
Owners	4.9	4.2	1.6	63
Owners/renters	6.0	4.7	1.3	74
Renters	5.2	3.7	1.0	72
Laborers	0.7	0.4	0.2	50
Corn/other rent[b]	7.8	6.2	1.7	62
Other occupation	1.1	0.8	0.5	29
Total sample	5.3	3.9	1.3	67

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] A "large" farm is any farm where more than an average of 2 hectares per round was cultivated.

[b] Corn growers who rent in land on fixed-rate or other types of arrangements.

Average returns to corn production are a dismal P1,023 per hectare per crop (US$51; partly in cash, partly in the form of own-produced corn consumption). Share tenants do worse than this average, since the share paid to their landlords has been subtracted.

The Sugar Production System

One of the primary differences between production of corn and of sugar is the way processing and marketing are organized. With corn, individual households may make independent decisions as to when to plant, harvest, and market their corn (subject, of course, to rainfall patterns). With sugar, production must be coordinated among several producers so that milling capacity is as fully utilized as possible without overproduction.

A second basic difference between production of the two crops is the length of the growing period, 3.3 months on average for corn for the sample households and 12.0 months for sugar. For sugar, 12.0 months is only the average time between harvests, not between plantings, since sugar may be ratooned. There are substantially higher input costs for the plant crop than for successive ratoons.

The sugar milling season begins in late October and ends in late July. The sugar content of the cane tends to be highest in March and April, when there is less rain. Most farmers would prefer to plan for harvesting then, but the mill prefers to process cane more or less evenly throughout the milling season.

The problem of coordinating the planting and harvesting of all contracted hectares is resolved ingeniously through a system that revolves around the *bagon* (wagon), or metal carrier, that sits on a truck bed and is lifted by cranes to dump the cane onto a conveyor belt at the mill. One *bagon* can service roughly 40 hectares if it is filled to capacity and delivered each day that the mill is in operation during the nine-month milling season. The mill assigns one *bagon* to each group of farmers with sugar contracts that total 40 hectares (operators of large farms would have several *bagons* at their disposal). Each group of smallholder farmers, then, must arrange a mutually agreeable schedule for utilization of that *bagon* capacity during each day of the milling season.

Several of the sugar household respondents had no contracts with the mill but worked out deals with growers who did not want to plant sugarcane up to the maximum of their contracted hectares ("deficit" producers).

A typical arrangement might be for a surplus grower to sell sugarcane to the deficit grower at a certain rate per truckload of cane. The deficit planter proceeds to the surplus grower's field with a truck and laborers, who cut and load the cane into the deficit planter's *bagon*. The deficit grower, who undertakes the expense of harvesting and hauling the cane, brings the cane to the mill as if it were his own production. This type of arrangement presents no particular problem for operation of the overall system just outlined.

When the cane is brought to the mill, it is weighed and a sample is taken to determine its sugar content. The grower is paid the National Sugar Trading Agency (NASUTRA, the government agency to which mills were required by law to sell their output) price for 60 percent of the sugar equivalent and the remaining 40 percent is retained by BUSCO. The grower is also paid a transportation rebate by the mill for the hauling of the mill's 40 percent of the cane. This rebate is paid on a kilometer and ton basis, so that farms farther away from the mill get a higher rebate. However, while contracts are given to farms outside of a 20-kilometer radius from the mill, rebates are paid only up to a maximum of 20 kilometers.

In the past growers were paid, usually within a month of depositing a truckload of cane at the mill, a single payment for both sugar and trucking rebate. Toward the end of the survey period, payments were delayed three months and more. Since a single grower may deliver several truckloads throughout the milling season, payments are staggered throughout the year. Some growers have large enough operations that it is more profitable to buy and use their own trucks to haul their cane. The growers in the sample were small enough that in all cases they hired private truckers to haul their cane.

Table 10 shows that average sugarcane yields were nearly identical across tenure groups. There was an almost uniform drop in yields across tenure groups between the two milling seasons recorded in the survey rounds.

The average total labor input per hectare was 109 days. The proportion of family labor in total labor for all groups was about one-third, with the exception of the sugar owner/renter group, which hired nearly 90 percent of its total labor inputs. Weeding accounted for 45 percent of all labor inputs and harvesting for 35 percent. Land preparation accounted for a low percentage of total labor inputs, partly because of the practice of ratooning, but also because tractor usage is much higher than for corn.

As indicated in Table 11, women contributed 9 percent of family labor and 11 percent of hired labor for sugar, lower percentages than for corn. As with family labor for corn, women are almost entirely excluded from tasks involving a carabao and participate, along with several children, in all other tasks except preparing the ratoon. In the hired

Table 10—Sugar yields, by crop-tenancy group and milling season, 1984/85

	By Milling Season			
Crop-Tenancy Group	1983/84 Milling Season	1984/85 Milling Season	Two Milling Seasons Combined	Average Ratoon Number
	(metric tons of cane/hectare)			
Sugar owners	59.5	40.6	49.8	1.7
Sugar owners/renters	53.4	37.3	43.2	1.8
Sugar renters	67.8	35.7	48.3	1.6
Large[a]	82.0	38.5	54.8	1.6
Small	50.8	31.6	39.6	1.6
Total sample	59.1	38.3	47.2	1.7

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] A "large" farm is any farm where more than an average of 2 hectares per round was cultivated.

Table 11—Total labor inputs per sugar crop, by crop-tenancy group and family and hired labor, 1984/85

	Family Labor			Hired Labor		
Crop-Tenancy Group	Men	Women	Children	Men	Women	Children
	(person-days)					
Sugar owners	20.7	3.8	20.9	67.7	9.0	1.4
Sugar owners/renters	8.5	0.6	2.7	77.6	9.1	0.5
Sugar renters	19.5	3.5	5.4	52.5	6.3	0.4
Large[a]	15.1	4.2	5.5	53.1	5.9	0.8
Small	25.4	2.6	5.3	51.8	6.8	0.0
Total sample	16.5	2.7	11.9	68.2	8.6	0.9

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] A "large" farm is any farm where more than an average of 2 hectares per round was cultivated.

labor force, women's participation rates fall when compared with corn, primarily because they are excluded from harvesting.

Average fertilizer usage per hectare per crop is between two and three times higher for sugar than for corn, although the duration of the growing cycle is much longer for sugar. The sugar owner/renter group uses the most fertilizer, 16 kilograms of nitrogen per hectare, which in absolute terms is still quite low.

Wage levels for all tasks are similar to those paid to corn laborers. There are not any obvious patterns of wage differentials across tenancy groups. As with corn, the wage paid for harvesting is substantially higher than for other tasks and about equal to the wage paid to corn harvesters at P27 per day.

Average expenditure per hectare for all household groups was P2,200, virtually all of which was paid out in cash. Thus, not only are production expenses much higher per crop per hectare than for corn, but a much higher proportion is paid out in cash. As with corn, about two-thirds of total expenses are paid out as wages. Total expenditures for the sugar owner/renter group are somewhat higher than average. Total expenditures for the small sugar renter group are well below the average due to lower levels of nonlabor inputs.

Plant crop expenses are, on average, about P800 more per hectare than ratoon crop expenses. If fertilizer applications had been constant across plant and ratoon crops, this differential would have been larger.

The price paid for sugar changed three times during the two milling seasons. At the beginning of the 1983/84 milling season, the price per picul[2] of sugar stood at P85. Toward the end of the milling season, this price was raised to P96. By the beginning of the 1984/85 milling season this price had increased to P107, and at about the middle of the milling season the price increased sharply to P171 per picul (the result of a devaluation of the peso).

Average returns of P4,500 per hectare per crop for sugar were well above those for corn. As with corn, landowners do better than renters because of the variable cost-accounting method used. Economic returns to corn and sugar production are examined more closely in the following section.

Comparison of Profits and Labor Allocation Patterns

Table 12 shows net revenues for corn and sugar (calculated on a variable cost basis) and net profits per hectare after subtraction of imputed values for family labor, inputs for carabaos owned by the household, interest on cash inputs, and rents on owned land. Except for land prices, the introduction of sugar did not affect the local prices of these inputs, or the output price for corn. Before finally subtracting an imputed value for owned land, a subtotal is calculated in which imputed values for family labor, owned-carabao inputs, and interest on cash have been subtracted from net revenues.

For corn laborers this subtotal is negative. This implies that these households could have had a higher income by hiring out their family labor and carabaos on the labor and carabao rental markets rather than devoting these inputs to corn production—assuming that employment is readily available if desired. Corn share tenants barely do better than break even, compared with the alternative of employment in the labor market.

In general, corn production by sugar households earns the highest returns net of family labor, carabao inputs, and interest on cash. The corn mixed tenancy group does nearly as well, but the pure corn landowner group does less well. Net profits are higher for sugar relative to corn, compared with net revenues for sugar relative to corn, since family inputs are greater for corn.

The final calculation shown in Table 12 is to subtract imputed rental values on owned land. Several negative entries in the final column for corn indicate that these households would have done better to rent out their land at the assumed rate (and enter the labor market) rather than to have undertaken corn production. This is not to say that farmer behavior is economically irrational. Yields and prices obviously cannot be predicted with complete accuracy, and some value may be attached to working for oneself rather than for someone else. But the low average value (a net profit of only P93 per hectare per crop) for the total sample indicates what a marginal activity corn production has become over time for smallholders.

Net profits for corn and sugar for the sugar owner/renter and sugar owner groups are roughly equal after doubling corn profits to take account of the two crops per year that can be planted to corn. These households would appear to have done a good job of allocating resources between sugar and corn production so as to have equalized marginal returns in both activities. This does not appear to be the case, however, for

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[2] One picul equals 60.477 kilograms.

Table 12—Corn and sugar production profits, by crop-tenancy group and farm size, 1984/85

	Corn					Sugar				
Crop-Tenancy Group[a]	Net Revenues per Hectare	Value Imputed to Family-Owned Inputs[b]	Sub-total	Rent on Owned Land	Net Profit per Hectare	Net Revenues per Hectare	Value Imputed to Family-Owned Inputs[b]	Sub-total	Rent on Owned Land	Net Profit per Hectare
					(pesos/hectare/crop)					
Corn										
Owners	1,038	720	318	447	−129	. . .	. . .	. . .	. . .	. . .
Large	1,057	716	341	447	−106	. . .	. . .	. . .	. . .	. . .
Small	993	728	265	447	−182	. . .	. . .	. . .	. . .	. . .
Owners/share tenants	1,390	688	702	292	410	. . .	. . .	. . .	. . .	. . .
Large	1,459	646	813	315	498	. . .	. . .	. . .	. . .	. . .
Small	1,215	810	405	233	172	. . .	. . .	. . .	. . .	. . .
Share tenants	774	698	76	. . .	76	. . .	. . .	. . .	. . .	. . .
Large	802	652	150	. . .	150	. . .	. . .	. . .	. . .	. . .
Small	748	742	6	. . .	6	. . .	. . .	. . .	. . .	. . .
Laborers	685	894	−209	231	−440	. . .	. . .	. . .	. . .	. . .
Sugar										
Owners	1,665	714	951	447	504	5,250	1,455	3,795	2,250	1,545
Owners/renters	1,315	620	698	92	606	3,727	1,096	2,631	1,625	1,006
Renters	1,041	840	201	. . .	201	2,853	1,226	1,627	75	1,552
Large	. . .	. . .	. . .	. . .	. . .	3,533	1,247	2,286	75	2,211
Small	. . .	. . .	. . .	. . .	. . .	1,970	1,198	772	75	697
Laborers	780	772	8	57	−49	. . .	. . .	. . .	. . .	. . .
Corn/other rent[c]	940	685	255	345	−90	. . .	. . .	. . .	. . .	. . .
Other occupation	818	792	26	249	−223	. . .	. . .	. . .	. . .	. . .
Total sample	1,023	728	295	202	93	4,570	1,298	3,274	1,910	1,364

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] A "large" farm is any farm where more than an average of 2 hectares per round was cultivated.

[b] Values imputed to family-owned inputs were for family labor, carabao inputs, and an assumed interest rate for cash inputs.

[c] Corn growers who rent in land on fixed-rate or other types of arrangements.

sugar renter households, which seem to have overinvested family labor in corn production.

Table 13 shows average labor inputs for corn and sugar production. The corn figures have been doubled to take account of the two corn crops that are harvested for each sugar crop. Corn and sugar production use almost identical amounts of total labor. As previously mentioned, however, the mixes of family and hired labor, and of men's, women's, and children's labor are quite different. While the substitution of hired for family labor in switching from corn to sugar production is perhaps marginally overstated in Table 13 due to the larger farm sizes of the sugar households, most of this substitution would appear to be related to the particular characteristics of the corn and sugar technologies themselves. As a proportion of total labor inputs, harvesting is about twice as important for sugar production as for corn production (both technologies use primarily hired labor for this step in the production process). This explains more than one-half of the increase in hired labor for sugar production. Tasks involving carabaos and postharvest processing explain more than one-half of the increase in family labor for corn production. Tractor use, which does not appear to be strongly related to farm size, is commonly used for land preparation in sugar production. Women's participation in household production declines dramatically with a switch from corn to sugar production, from 12.4 days per hectare for corn to only 2.7 days for sugar.

Other Sources of Income

The following chapters will analyze how incomes generated from the production of corn and sugar are spent and how time allocation and expenditure decisions affect the nutrition of preschoolers. Before proceeding, however, it is important to keep in mind that the sources of income for these households are very diverse, especially for households with access to land.

Table 14 shows the percentage distribution of various sources of income, disaggregated by expenditure quintile and by crop and tenure group. For corn households with

Table 13—Labor inputs for corn and sugar, by family and hired labor, 1984/85

Labor Group	Corn[a]	Sugar[b]
	(person-days/hectare)	
Family labor	70.0	31.0
Men	40.2	16.5
Women	12.4	2.7
Children	17.4	11.9
Hired labor	39.2	77.6
Men	26.0	68.2
Women	11.0	8.6
Children	2.2	0.9
Total labor	109.2	108.6
Men	66.2	84.7
Women	23.4	11.3
Children	19.6	12.8

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

Note: Labor inputs shown are for the total survey sample and include postharvest processing.

[a] Corn figures are for two crops.

[b] Sugar figures are for one crop.

Table 14—Sources of income, by expenditure quintile and crop-tenancy group, 1984/85

Group	Farm Production Income						Off-Farm Income			
	Sugar	Corn	Rice	Other	Backyard	Sub-total	Agricultural Wages	Nonagricultural Wages, Business, Other	Sub-total	Total
						(percent)				
Expenditure quintile[a]										
1	2	22	3	2	23	52	31	17	49	100
2	3	16	3	3	18	43	39	19	58	100
3	7	21	4	3	18	53	28	20	48	100
4	10	18	3	6	18	54	20	27	47	100
5	25	18	7	4	10	64	2	35	37	100
All	16	18	5	4	14	57	15	29	44	100
Crop-tenancy group										
Corn	0	29	5	7	19	60	17	23	40	100
Owners	0	25	5	13	22	65	4	31	35	100
Owners/share tenants	0	44	9	8	16	77	8	16	24	100
Share tenants	0	33	4	3	20	60	16	24	40	100
Laborers	0	6	0	1	17	24	65	11	76	100
Sugar	33	10	6	2	10	61	13	27	40	100
Owners	42	12	5	3	9	71	3	26	29	100
Owners/renters	33	8	10	2	9	61	2	36	38	100
Renters	34	15	2	0	14	65	9	26	35	100
Laborers	0	3	1	0	13	17	76	7	83	100

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

Note: Averages are weighted by absolute amount of income earned by individual households.

[a] Expenditure quintile 1 is the lowest rank and 5 the highest.

access to land, profits from corn production account for only about a third of total income. Sugar households with access to land derive about the same proportion of their income from sugar production.

For both crop groups with access to land, income from nonagricultural sources contributes a quarter of total income. Backyard livestock, vegetable, and fruit production is a more important component of income for corn households with access to land than for sugar households with access to land, partly because livestock production is a complementary activity to corn production.

Rice and corn production account for about 15 percent of income for sugar households with access to land. Crops other than sugar, rice, and corn do not figure prominently for these households. For corn households with access to land, rice and other crops provide significant proportions of income for owner and owner/renter households but not for share tenant households.

Landless laborer households, whether corn or sugar, are the most dependent on a single source of income, agricultural wages, which constitutes from two-thirds to three-fourths of total income. For these households, backyard production, at roughly 15 percent, is the second largest component of income.

6

FOOD EXPENDITURES AND CALORIE INTAKES

The links between income and food expenditures at the household level, between food expenditures and household calorie intakes, and between household calorie intakes and preschooler calorie intakes for corn and sugar families are examined in this chapter. For reasons developed at length elsewhere (Bouis and Haddad 1989), total expenditures and *calorie intakes* derived from the 24-hour recall of foods consumed by a family are believed to give the best indication of the effect of increases in purchasing power on improved calorie consumption at the household level. A commonly followed alternative would have been to estimate the relationship between *calorie availability* (derived from food-expenditure information) and *total expenditures*.

Appendix 2 contains a discussion of how data on incomes, expenditures, nutrient availability, and nutrient intakes were collected, which data are more reliable, and how these variables are related empirically. See Table 26 for estimates of the income elasticities based on the two-way relationship shown in Table 15. See Appendix 3 (Tables 27-29) for descriptive statistics of the variables used in the following analyses and for the results of various structural and exogeneity tests.

Food Expenditures as a Function of Income

Table 15 presents data for per capita income, total expenditures, food expenditures, per adult-equivalent calorie availability, and calorie intakes disaggregated by income quintile, total expenditure quintile, and crop-tenancy group. As expected, food budget shares decline and household calorie consumption increases with income.

Sugar households purchase an average of about 15 percent more of their food in the market than do corn households, with proportions between own-produced food and market purchases invariant with tenure status. Conversely, about 15 percent more of corn-household food purchases come from their own production. This is not invariant with tenure status, as households with access to more land produce a higher percentage of their own needs. Laborer households make up for a lower home production percentage with higher percentages of in-kind wages.

Much of the difference between corn and sugar households in the percentage distribution of market purchases can be explained by differences between the two groups in their purchases of rice and corn, the two main staples. As indicated previously, sugar-household purchases of rice in the market are higher than corn-household purchases. Prices paid for corn grits and rice do not vary by income group. An F-test indicates that the marginal propensity to consume rice out of income is significantly higher for sugar households than for corn households.

The results of estimating the relationship between income and food expenditures are given in Table 16. The coefficients on the income terms are positive and significant for all three samples (corn households, sugar households, and the combined sample). Out of each additional peso of income, the marginal propensities to spend for food are 49 centavos for the whole sample, 52 centavos for corn households, and 39 centavos for sugar households. In accordance with Engel's law, the higher-income sugar households

Table 15—Income, expenditures, and calorie availability and intake, by income and expenditure quintiles and crop-tenancy group, 1984/85

Group	Per Capita Income	Total Expenditures	Family Food Expenditures	Food Budget Share[a]	Calorie Availability[b]	Calorie Intake[c]
		(pesos/week)[d]		(percent)	(per day)	
Income quintile[e]						
1	13.1	30.0	24.0	80	2,170	2,266
2	21.9	36.6	26.6	73	2,237	2,313
3	29.8	39.7	28.5	72	2,321	2,336
4	41.4	48.1	33.3	69	2,639	2,433
5	101.7	76.2	43.2	57	2,826	2,443
All	41.7	46.2	31.1	67	2,439	2,358
Expenditure quintile[e]						
1	21.9	21.8	17.2	79	1,790	2,108
2	25.4	29.8	23.4	79	2,143	2,288
3	28.5	38.0	28.8	76	2,411	2,384
4	45.8	50.0	34.8	70	2,666	2,439
5	87.6	91.9	51.7	56	3,193	2,575
All	41.7	46.2	31.1	67	2,439	2,358
Crop-tenancy group						
Corn	35.2	41.4	29.3	71	2,375	2,372
Owners	47.7	49.2	32.7	66	2,445	2,387
Owners/share tenants	46.4	46.6	30.4	65	2,368	2,329
Share tenants	28.4	40.0	29.6	74	2,405	2,412
Laborers	26.6	32.3	24.9	77	2,266	2,326
Sugar	52.2	53.5	33.7	63	2,534	2,343
Owners	70.1	64.4	39.3	61	2,655	2,386
Owners/renters	83.3	89.9	47.5	53	3,148	2,447
Renters	43.0	43.5	30.0	69	2,350	2,371
Laborers	26.5	30.8	24.0	78	2,208	2,237

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

Note: Parts may not add to totals because of rounding.

[a] Food budget share = family food expenditures/total expenditures; shares are weighted by total expenditures for individual households.

[b] Per adult-equivalent, derived from food expenditures.

[c] Derived from 24-hour recall of foods consumed.

[d] 1984 pesos.

[e] Quintile 1 is the lowest rank and 5 the highest.

spend a lower proportion of their incremental income on food. However, the range of the corresponding elasticities, 0.65, 0.63, and 0.57, is smaller. Food expenditures rise rapidly with income.

The test for equality of coefficients across corn and sugar households gave an F-value of 4.26, which is above the critical value. Changes in demand for household labor between sugar and corn production, especially for women, changes in demand preferences for rice and corn, and differences in percentage of food purchased in the market could all account for this result.

Calorie Intakes as a Function of Food Expenditures

Calories purchased per peso decline with increasing income, reflecting the declining share of staples in the diet as higher-income households seek more variety in what they eat. The food-expenditure data indicate that households in the highest expenditure

Table 16—Regression results for the relationship between income and food expenditures

Variable	All Households		Corn Households		Sugar Households	
(Constant)	-25.15210	(-4.38)	-15.53920	(-2.04)	-28.45140	(-3.26)
LNY	20.38670	(16.90)*	18.49230	(9.74)*	19.08450	(13.14)*
MOTHED	0.91819	(5.08)*	0.66936	(2.86)*	1.29299	(4.57)*
FATHED	-0.41277	(-2.35)*	-0.71002	(-2.68)*	0.60185	(2.55)*
MOTHAGE	-0.32516	(-3.25)*	-0.52139	(-4.10)*	0.27850	(1.78)
FATHAGE	0.11586	(1.49)	0.18369	(1.87)	-0.17939	(-1.46)
NUTRSC1	-0.43354	(-3.02)*	-0.59274	(-3.19)*	-0.22091	(-0.96)
PRCORN	0.82957	(1.14)	-0.11026	(-0.13)	1.78659	(1.53)
PRRICE	-1.38213	(-2.41)*	-0.45116	(-0.62)	-3.53981	(-3.98)*
PCTHOME	0.00253	(0.15)	0.02339	(1.08)	-0.04679	(-1.82)
POPDEN	-0.02133	(-2.33)*	-0.01569	(-1.34)	-0.00951	(-0.64)
ADEQVHH	-0.39700	(-1.48)	-0.17440	(-0.45)	-0.81660	(-2.33)*
RD1	4.14243	(3.70)*	5.28186	(3.81)*	1.68067	(0.99)
RD2	0.79826	(0.64)	3.40079	(2.15)*	-3.40899	(-1.82)
RD3	1.59086	(1.30)	2.26638	(1.48)	0.54071	(0.29)
	R^2 =	0.362	R^2 =	0.280	R^2 =	0.476
	F =	65.32	F =	25.36	F =	36.88
	N =	1,624	N =	928	N =	624
Marginal propensity to spend for food		0.49		0.52		0.39
Food expenditure elasticity with respect to income		0.65		0.63		0.57

Notes: The dependent variable is food expenditures per capita per week. t-statistics are in parentheses.
*Significant at the 0.05 level.
Definitions of variables:
LNY = predicted natural logarithm of income, in pesos per capita per week;
MOTHED = years of formal education of the mother;
FATHED = years of formal education of the father;
MOTHAGE = age of mother in months;
FATHAGE = age of father in months;
NUTRSC1 = measure of the nutritional knowledge of the mother;
PRCORN = quality-adjusted real price of corn;
PRRICE = quality-adjusted real price of rice;
PCTHOME = percentage of food expenditures coming from own-farm production;
POPDEN = population density of the muncipality;
ADEQVHH = number of household members expressed in adult-equivalents; and
RD1,RD2,RD3 = zero-one dummy variables for round.

quintile spend 60 percent more than those in the lowest expenditure quintile for equal amounts of calories.

Table 17, which disaggregates food expenditures by five broad food groups, indicates the types of calorie-expensive foods the higher-income groups in the sample demand. Overwhelmingly, it is the meat category that increases its share with income as the staple share declines. The category of fruits, snacks, desserts, and beverages increases its share with income, although the percentage share remains low. The shares of the remaining two food groups remain nearly constant with rising income.

The regression results in Table 18 show that household calorie intakes increase positively and significantly as food expenditures increase. At mean food expenditure levels, each extra peso spent for food increased household calorie intake (per adult-equivalent) by only about 90 calories *at the margin* for the sample as a whole, compared

Table 17—Allocation of weekly per capita food expenditures, by food group, expenditure quintile, and crop-tenancy group, 1984/85

Group	Staples	Meat, Eggs/Fish	Vegetables, Legumes	Fruits, Snacks, Desserts, Beverages	Cooking Ingredients	All
			(percent)			
Expenditure quintile[a]						
1	61	20	5	7	7	100
2	56	25	5	8	7	100
3	52	27	5	9	8	100
4	45	31	5	11	8	100
5	37	39	6	12	7	100
All	48	30	5	10	7	100
Crop-tenancy group						
Corn	49	28	5	10	7	100
Owners	45	31	4	13	7	100
Owners/share tenants	47	31	5	9	8	100
Share tenants	50	29	5	9	8	100
Laborers	56	23	5	9	7	100
Sugar	46	31	5	10	7	100
Owners	42	35	5	11	7	100
Owners/renters	40	36	5	12	7	100
Renters	48	30	6	10	7	100
Laborers	56	24	5	9	7	100

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

Note: Averages are weighted by food expenditures for individual households.

[a] Quintile 1 is the lowest rank and 5 the highest.

with more than 400 calories purchased *on average* by a peso spent on food. The estimated household calorie intake elasticities with respect to food expenditures are 0.17 for the sample as a whole and 0.15 and 0.21 for corn and sugar households, respectively. Testing for the equality of coefficients across corn and sugar groups, an F-value of 0.79 does not reject the null hypothesis.

Direct Estimation of the Calorie-Income Elasticity

Calorie-income elasticities for the entire sample of 1,624 observations have been directly estimated using four econometric techniques (ordinary least squares, instrumental variables, and two techniques designed to take account of unobserved household-specific effects; a detailed presentation is provided in Bouis and Haddad 1989). The instrumental variable technique gave a calorie-income elasticity estimate of 0.11, and the two fixed-effect techniques gave estimates of 0.06 and 0.05, using calorie intakes and total expenditures as dependent and explanatory variables, respectively. These estimates, then, are nearly identical to the 0.11 estimate derived using the two-step procedure outlined above (obtained by multiplying 0.65 and 0.17) and suggest that household unobserved effects are empirically relatively unimportant in this instance.

The expenditure behavior indicated by the regression results reveals a high degree of leakage between higher incomes and increases in calorie intakes at the household level. The striking conclusion is that as incomes double, household calorie intakes increase by only about 10 percent for both corn and sugar households (less than 10 percent if the panel estimates are used).

Table 18—Regression results for the relationship between calorie intakes and food expenditures

Variable	All Households		Corn Households		Sugar Households	
(Constant)	1,699.20348	(7.15)	1,572.79891	(4.65)	1,900.12249	(5.14)
LNFFEX	399.57051	(9.80)*	348.18092	(5.85)*	486.02863	(7.95)*
MOTHED	−6.55484	(−0.81)	4.39447	(0.38)	−17.99340	(−1.43)
FATHED	−10.29226	(−1.44)	−9.53054	(−0.90)	−13.14178	(−1.27)
MOTHAGE	−1.00478	(−0.24)	−0.71330	(−0.12)	−6.58987	(−0.97)
FATHAGE	−3.82640	(−1.11)	0.03981	(0.01)	−5.12551	(−0.96)
NUTRSC1	9.00880	(1.54)	9.91045	(1.28)	4.41642	(0.45)
PRCORN	−40.57495	(−1.27)	−7.10563	(−0.17)	−93.01054	(−1.81)
PRRICE	25.92191	(1.07)	22.96462	(0.67)	39.97245	(1.04)
PCTHOME	0.65529	(0.92)	0.73085	(0.71)	1.31968	(1.17)
POPDEN	−2.03446	(−5.05)*	−1.75213	(−3.06)*	−2.76975	(−4.25)*
ADEQVHH	−34.17901	(−2.95)*	−48.58973	(−2.69)*	−19.60127	(−1.28)
RD1	160.01210	(3.22)*	207.05062	(3.00)*	116.27610	(1.56)
RD2	5.53448	(0.10)	−47.53876	(−0.61)	83.46194	(1.01)
RD3	−117.68181	(−2.18)*	−139.32955	(−1.85)	−100.18397	(−1.23)
	R^2 =	0.125	R^2 =	0.117	R^2 =	0.176
	F =	16.43	F =	8.60	F =	9.27
	N =	1,624	N =	928	N =	624
Calories purchased for each additional peso spent on food		89.8		83.1		100.8
Household calorie intake elasticity with respect to food expenditures		0.17		0.15		0.21

Notes: The dependent variable is household calorie intake per adult-equivalent per day. t-statistics are in parentheses.

*Significant at the 0.05 level.

Definitions of variables:

LNFFEX = natural logarithm of food expenditures, in pesos per capita per week;
MOTHED = years of formal education of the mother;
FATHED = years of formal education of the father;
MOTHAGE = age of mother in months;
FATHAGE = age of father in months;
NUTRSC1 = measure of the nutritional knowledge of the mother;
PRCORN = quality-adjusted real price of corn;
PRRICE = quality-adjusted real price of rice;
PCTHOME = percentage of food expenditures coming from own-farm production;
POPDEN = population density of the muncipality;
ADEQVHH = number of household members expressed in adult-equivalents; and
RD1,RD2,RD3 = zero-one dummy variables for round.

Preschooler Calorie Intakes as a Function of Family Intakes

Table 19 presents average calorie adequacy ratios for various age groupings by expenditure group and crop-tenancy group. These ratios are computed by dividing actual calorie intakes (taken from the 24-hour recall of individual food intakes) by the recommended calorie intakes for the appropriate age and sex (Food and Nutrition Research Institute 1984). Only preschoolers for whom breastfeeding has already been stopped are included in the table, because data were not collected on calorie intakes from breast milk. Consequently, currently breastfed children were also excluded from the regressions reported on below and in the following chapter.

Table 19—Calorie adequacy, by family member, expenditure quintile, and crop-tenancy group, 1984/85

Group	Average Calorie Adequacy Ratio					Percent Below 80 Percent of Caloric Requirements				
	Preschoolers (0-4)	Children (5-14)	Adolescents (>14)	Mothers	Fathers	Preschoolers (0-4)	Children (5-14)	Adolescents (>14)	Mothers	Fathers
Expenditure quintile[a]										
1	0.69	0.71	0.84	1.03	0.98	56	66	41	24	28
2	0.75	0.74	0.83	1.08	1.06	47	61	41	23	21
3	0.74	0.79	0.84	1.15	1.08	54	56	41	18	19
4	0.77	0.77	0.91	1.12	1.10	53	56	37	19	21
5	0.83	0.87	0.92	1.21	1.14	47	46	29	14	15
All	0.75	0.77	0.87	1.12	1.07	52	58	38	19	21
Crop-tenancy group										
Corn	0.76	0.77	0.87	1.12	1.06	63	58	38	20	23
Owners	0.82	0.78	0.89	1.19	1.10	56	56	33	15	18
Owners/share tenants	0.73	0.77	0.82	1.15	1.05	67	57	46	23	24
Share tenants	0.77	0.76	0.89	1.11	1.05	61	58	36	19	22
Laborers	0.76	0.77	0.91	1.05	1.01	66	58	35	24	28
Sugar	0.72	0.75	0.89	1.10	1.10	66	59	37	20	18
Owners	0.74	0.80	0.91	1.13	1.12	65	56	33	18	17
Owners/renters	0.76	0.77	0.91	1.15	1.15	61	53	35	13	15
Renters	0.71	0.76	0.82	1.13	1.13	67	60	42	19	13
Laborers	0.71	0.70	0.75	1.03	1.04	66	63	53	26	23

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

Note: Parts may not add to totals because of rounding.

[a] Quintile 1 is the lowest rank and 5 the highest.

Table 19 shows that preschoolers on average are consuming only about 75 percent of their recommended daily intakes, while adults are consuming slightly above their recommended levels. Comparing calorie adequacy ratios across the various crop-tenancy groups, preschoolers in corn households consume more calories than sugar-household preschoolers. While the difference is not large, it is still surprising in view of the higher incomes in sugar households.

Table 20 presents the regression estimates for preschooler calorie intakes as a function of household calorie intakes. For all three samples, the household calorie intake was found to be a positive and significant determinant of preschooler calorie intake. At the margin, calories are distributed more or less equally among household members, increasing the percentage of household calories going to preschoolers, who consume below average household levels. For the whole sample and subsamples of corn and

Table 20—Regression results for preschooler calorie intakes as a function of household calorie intakes

Variable	All Households		Corn Households		Sugar Households	
(Constant)	263.42399	(1.12)	530.87080	(1.69)	98.99475	(0.26)
HCALAEQ	0.82028	(30.86)*	0.84577	(25.52)*	0.77578	(16.68)*
RATIOPAR	−1,483.48814	(−14.01)*	−1,588.46312	(−11.22)*	−1,320.44308	(−7.57)*
MOTHED	16.79655	(2.26)*	17.66845	(1.93)	5.11738	(0.35)
MOTHAGE	1.03590	(3.37)*	1.02134	(2.68)*	0.79280	(1.46)
NUTRSC1	−3.42859	(−0.55)	−13.81724	(−1.86)	25.15519	(2.11)*
CHILDCRE	0.32042	(1.63)	0.51105	(2.04)*	0.05842	(0.18)
SICK	−81.70871	(−1.90)	−137.87299	(−2.57)*	38.38262	(0.51)
SEX	65.98609	(1.73)	45.64234	(0.96)	72.80922	(1.07)
ACCAGE	43.84393	(4.84)*	39.98655	(3.27)*	35.74011	(2.45)*
AGESQ	−0.54548	(−4.56)*	−0.52775	(−3.32)*	−0.35900	(−1.81)
ADEQVHH	49.24556	(3.61)*	60.88718	(3.35)*	34.94330	(1.62)
RD1	−2.93130	(−0.06)	−47.44410	(−0.71)	60.91730	(0.65)
RD2	−65.62428	(−1.23)	−94.31894	(−1.39)	−13.65748	(−0.15)
RD3	−110.98226	(−2.08)*	−110.95572	(−1.65)	−106.97079	(−1.17)
	R^2 =	0.769	R^2 =	0.792	R^2 =	0.567
	F =	99.08	F =	68.91	F =	30.90
	N =	975	N =	587	N =	345
Preschooler calorie intake elasticity with respect to household calorie intake		1.18		1.20		1.17

Notes: The dependent variable is preschooler calorie intake per adult-equivalent per day. t-statistics are in parentheses.

*Significant at the 0.05 level.

Definitions of variables:

HCALAEQ = household calorie intake per adult-equivalent per day;
RATIOPAR = ratio of average of father's and mother's calorie intake per adult-equivalent over the household calorie intake per adult-equivalent;
MOTHED = years of formal education of the mother;
MOTHAGE = mother's age in months;
CHILDCRE = minutes spent by mother in child care in previous 24 hours;
NUTRSC1 = measure of nutritional knowledge of the mother;
SICK = zero-one dummy for reporting sickness in previous two weeks;
SEX = 0 = female, 1 = male;
ACCAGE = age of preschooler in months;
AGESQ = age of preschooler squared;
ADEQVHH = number of household members expressed in adult-equivalents;
RD1,RD2,RD3 = zero-one dummy variables for round.

sugar households the estimated preschooler calorie-intake elasticities with respect to household calorie intakes are 1.18, 1.20, and 1.17, respectively.

The F-test for equality of coefficients between the corn and sugar households indicated that the coefficients were significantly different for the two subsamples. Discussion of the reasons for this particular result will be postponed until differences in mothers' time allocation patterns between corn and sugar households are discussed in Chapter 7.

Multiplying the calorie-income elasticities reported in the previous section by the cited elasticities of 1.18, 1.20, and 1.17 gives the percentage increase in preschooler intakes over the percentage increase in income, or 0.13, 0.11, and 0.14 for the whole sample, corn households, and sugar households, respectively. Because preschoolers start off so far below their recommended calorie intakes, though distribution is relatively equitable at the margin, even high-income households would have to realize substantial percentage increases in income for the calorie intakes of preschoolers to reach their recommended levels, given these low elasticity values.

7

HEIGHTS AND WEIGHTS OF PRESCHOOL CHILDREN

Anthropometric data on height and weight were collected in each of the four survey rounds for all individuals present in the household at the time of the interview. In this chapter the data for preschoolers are presented, and the effects of calorie intakes and several nonfood variables on their heights and weights are analyzed. The standards against which heights and weights are compared are the United States National Center for Health Statistics references for a healthy U.S. population.

Table 21 presents Z-scores for height-for-age, weight-for-age, and weight-for-height for all preschoolers, disaggregated by age and expenditure quintile. The height-for-age

Table 21—Z-scores for height-for-age, weight-for-age, and weight-for-height of preschoolers, by age and expenditure quintile, 1984/85

Expenditure Quintile[a]	Age of Preschoolers in Years					
	0	1	2	3	4	0-4
			Height-for-Age			
1	−2.08	−2.75	−2.62	−2.44	−2.69	−2.57
2	−1.24	−2.37	−2.26	−2.30	−2.46	−2.22
3	−1.20	−2.03	−2.04	−2.13	−2.17	−2.02
4	−0.91	−1.97	−1.86	−2.28	−2.30	−2.02
5	−0.82	−1.88	−1.76	−1.94	−1.91	−1.80
All	−1.31	−2.24	−2.15	−2.24	−2.34	−2.16
			Weight-for-Age			
1	−1.82	−2.15	−1.77	−1.53	−1.61	−1.75
2	−0.90	−2.06	−1.69	−1.62	−1.52	−1.62
3	−1.24	−1.76	−1.45	−1.42	−1.39	−1.47
4	−1.44	−1.71	−1.47	−1.45	−1.41	−1.49
5	−0.86	−1.60	−1.39	−1.30	−1.33	−1.35
All	−1.25	−1.88	−1.57	−1.48	−1.46	−1.55
			Weight-for-Height			
1	−0.47	−0.81	−0.73	−0.48	−0.50	−0.60
2	−0.07	−1.06	−0.82	−0.61	−0.40	−0.64
3	−0.46	−0.83	−0.62	−0.45	−0.40	−0.55
4	−0.92	−0.81	−0.77	−0.46	−0.51	−0.65
5	−0.47	−0.80	−0.66	−0.38	−0.42	−0.54
All	−0.43	−0.87	−0.72	−0.48	−0.45	−0.60

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

Note: The heights and weights of preschoolers were measured in each round so that Z-scores for any one preschooler are typically included in the mean calculations for two columns. U.S. National Center for Health Statistics (NCHS) standards were used for ease of comparison with the other four IFPRI microlevel studies of commercialization. The Food and Nutrition Research Institute (FNRI) in the Philippines has recently issued a set of reference values based on a national sample of apparently healthy Filipino children. Healthy Filipino children are close to the NCHS standard during the first half of infancy, gradually deviating from it as age advances. Thus it may be expected that Z-scores based on the NCHS standards gradually decline with age.

[a] Quintile 1 is the lowest rank and 5 the highest.

scores for preschoolers less than one year old indicate a very strong association between height and income. Although data are not presented to substantiate such a conclusion, this pattern is probably a reflection of better maternal nutrition in high-income groups during pregnancy and breastfeeding (see Bouis and Kennedy 1989 for a discussion of this topic).

As age increases and children are weaned, height-for-age Z-scores for all expenditure quintiles decline. However, they decline more rapidly for higher-income quintiles so that by the age of four years, heights of higher-income children are only marginally better than heights of lower-income children. There appears to be little association between income and weight-for-height. Weight-for-age Z-scores show a pattern that is a mix of the patterns for height-for-age and weight-for-height scores.

Height-for-age Z-scores disaggregated by crop-tenancy group for preschoolers who have been completely weaned are given in Table 22. Note that children in the two highest-income crop-tenancy groups (sugar owner and sugar owner/renter households) in the first age tercile are significantly taller than preschoolers in any of the remaining six groups. However, having started out significantly taller, sugar owner and sugar owner/renter children are shorter on average than their corn-household counterparts by the time they reach the oldest age tercile (although the difference is not statistically significant) despite their larger farms, higher profits from sugar, and higher incomes. Corn laborer and sugar laborer children in the oldest age tercile are significantly more stunted than children in any of the remaining six groups, a result that might have been expected because of their low incomes.

Causal factors that could potentially influence the above patterns of nutritional status, particularly mothers' time allocation, preschooler morbidity, health and sanitation practices and facilities, and mothers' nutritional knowledge, are discussed in the following sections.

Table 22—Height-for-age Z-scores for preschoolers who no longer breast-feed, by crop-tenancy group and age tercile, 1984/85

Crop-Tenancy Group	All Ages	Age Tercile 1	2	3
Corn	−2.21	−2.17	−2.18	−2.29*
Owners	−2.18	−2.12	−2.37	−2.07
Owners/share tenants	−2.19	−2.22	−2.15	−2.18
Share tenants	−2.12	−2.13	−1.99	−2.23
Laborers	−2.41	−2.25	−2.38	−2.64*,**
Sugar	−2.17	−1.97	−2.27	−2.37*
Owners	−1.97	−1.77**	−1.83	−2.32*
Owners/renters	−2.00	−1.84**	−2.05	−2.11*
Renters	−2.16	−2.11	−2.16	−2.28
Laborers	−2.39	−2.04	−2.77	−2.62*,**

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

* Significant difference at the 0.05 level between first and third age terciles within crop-tenancy group.

** Significantly different at the 0.10 level from all other crop-tenancy groups for the same age tercile; tests run only for first and third age terciles.

Time Allocation Patterns of Mothers

Mothers who are breastfeeding spend about 110 more minutes a day in child care than do nonbreastfeeding mothers. Less than half of this extra time is accounted for by breastfeeding itself. A comparison of like tenancy groups across crops (excluding the laborer groups) shows that breastfeeding time and other child-care time for children who are being breastfed is consistently higher for the sugar-household mothers than for the corn-household mothers. Once breastfeeding is stopped, child-care time is consistently lower for sugar-household mothers than for corn-household mothers (again excluding the laborer groups).

Such a result might have been predicted, given the assumptions underlying the economic theory of the household model, and given the reduced role of women in sugar production. Because the mother is relatively more tied to the house and baby during breastfeeding (for both corn and sugar households), the lower opportunity cost of women's time in sugar production will leave more time for child care for sugar-household mothers. Once breastfeeding is discontinued, however, sugar-household mothers have less incentive to stay at home, so child-care time will be reduced. This line of reasoning holds only for households with access to land. The pattern described above breaks down when comparing the corn laborer and sugar laborer mothers.

Table 23 shows that time in own-farm activities rises only marginally between breastfeeding mothers and mothers who have stopped breastfeeding for corn owner and corn owner/share tenant households, in contrast with sugar owner and sugar owner/renter mothers, who spend much less time in own-farm activities during breastfeeding than after. It can be presumed that time in own-farm activities of sugar owner and sugar owner/renter mothers, whose children get an especially good nutritional start, is similarly low during pregnancy as well (Bouis and Kennedy 1989).

Comparing like tenancy groups across crops (but excluding the laborer households), Table 23 shows that total time away from the house, which increases for all eight crop-tenancy groups once breastfeeding is stopped, is consistently lower for sugar-household mothers during breastfeeding, and consistently higher for sugar-household mothers once breastfeeding has been stopped. Most of these differences are statistically significant. Once breastfeeding has been stopped, corn-household mothers spend about one more hour each day away from the house than before they stopped, while sugar-household mothers spend about two more hours away from the house.

As noted earlier, corn-household preschoolers, after they have been weaned, are favored somewhat in the intrahousehold distribution of calories relative to their sugar-household counterparts. The dichotomy in mothers' time allocation patterns just discussed provides a plausible explanation for this statistically significant difference.

Preschooler Morbidity Patterns

Mothers were asked to provide information on the duration and symptoms of any type of illness that the preschooler may have suffered in the two weeks before the interview. Fever and diarrhea were the most frequently mentioned symptoms. After breastfeeding had been stopped, an average preschooler in the sample was sick once every six weeks (Table 24). The average duration of each reported sickness was about 4.5 days and did not vary much across expenditure or crop-tenancy groups.

Surprisingly, prevalence rates are higher for sugar households than for corn households. For sugar-household preschoolers, fever and diarrhea combined occur 25 percent

Table 23—Mothers' time away from the house, by breastfeeding status and crop-tenancy group, 1984/85

Crop-Tenancy Group	Time Away from House in Own-Farm Activities[a]			Time Away from House in Off-Farm Activities[b]			Total Time Away from House		
	Currently Breastfeeding	No Longer Breastfeeding	Net Change	Currently Breastfeeding	No Longer Breastfeeding	Net Change	Currently Breastfeeding	No Longer Breastfeeding	Net Change
					(minutes)				
Corn[c]	86**	118*,**	+32	105**	150*,**	+45	191**	269*,**	+78
Owners	108	130	+22	108	163	+55	215	292	+77
Owners/share tenants	108*	136	+28	96*,**	149*,**	+54	203**	285**	+82
Share tenants	91	107	+16	100*,**	150**	+50	191*,**	256**	+65
Laborers	58**	109*,**	+51	118	136*	+18	176**	245**	+69
Sugar[c]	69**	99*,**	+30	104**	196*,**	+92	172**	295*,**	+123
Owners	65**	118**	+53	102**	179**	+77	166**	297**	+131
Owners/renters	16*,**	101**	+85	165*	207*	+42	181**	309**	+128
Renters	84	113	+29	50*,**	182**	+132	134*,**	295**	+161
Laborers	79	69*	−10	109**	213*,**	+104	187**	282**	+95

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

Note: Data are for the 24-hour period prior to the survey interview.

[a] Cultivating fields, pasturing and watering work animals, fetching water, gathering firewood.

[b] Agricultural and nonagricultural employment, marketing, meetings, church, fiesta, visiting friends.

[c] Weighted by number of observations; weights differ between mothers who are currently breastfeeding and those who are no longer breastfeeding.

* Significantly different at the 0.05 level, comparing like tenancy groups across crops.

** Significantly different at the 0.05 level, comparing like variables across breastfeeding and nonbreastfeeding mothers.

Table 24—Prevalence of sickness among breastfeeding and nonbreastfeeding preschoolers, by expenditure quintile and crop-tenancy group, 1984/85

	Currently Breastfed Preschoolers			Preschoolers Who Have Stopped Breastfeeding		
Group	Sickness	Fever	Diarrhea	Sickness	Fever	Diarrhea
			(percent)[a]			
Expenditure quintile						
1	31	21	03	24	17	03
2	29	21	04	27	19	04
3	34	16	07	29	14	05
4	39	28	02	30	20	03
5	41	21	07	32	21	03
All	35	21	05	28	18	04
Crop-tenancy group						
Corn	32	22	05	27	17	03
Owners	22	11	03	24	15	01
Owners/share tenants	38	32	05	28	16	03
Share tenants	33	21	05	29	18	04
Laborers	31	21	04	26	19	04
Sugar	36	22	05	30	20	05
Owners	32	21	03	28	20	02
Owners/renters	43	17	04	32	20	06
Renters	34	28	03	32	21	03
Laborers	37	22	07	30	20	07

Source: International Food Policy Research Institute-Research Institute for Mindanao Culture survey, 1984/85.

[a] Percentage of children sick in the two weeks preceding the survey interview.

more frequently than for corn-household preschoolers (after breastfeeding has been stopped). The pattern of sickness across the crop groups is consistent with the more rapidly declining height-for-age Z-scores for sugar-household preschoolers as they grow older. Sugar-household mothers spend less time in child care and more time away from the house, even though their preschoolers are sick more often.

Health and Sanitation

Increases in income are associated with improved primary water sources, water sources that are closer to the house, improved toilet facilities, and better housing as measured by flooring and roofing materials. On average, these mean better facilities for sugar households, which have higher incomes. Laborer households have the least-improved toilets and poorest-quality floor material. For none of the sanitation variables considered are poorer facilities consistently associated with sugar households (which could explain the higher morbidity rates among sugar-household preschoolers), nor do improved facilities for higher-income households seem to have resulted in lower morbidity for preschoolers in these higher-income households.

Forty-three percent of preschoolers were ever bottlefed, compared with 94 percent ever breastfed. The practice of bottlefeeding is positively associated with rising incomes. Sugar-household mothers bottlefeed more frequently than their corn-household counterparts. Laborer-household mothers bottlefeed least, reflecting their lower purchasing power. Sugar-household mothers delay the introduction of weaning foods longer than corn-household mothers, stopping both breastfeeding and bottlefeeding at older ages, which is indicative of the greater time availability of sugar-household mothers for child care. While studies have shown that bottlefeeding is associated with higher morbidity than breastfeeding, this does little to explain why sickness would be higher for sugar-household children who are three and four years old.

Mothers' Nutritional Knowledge

In each of the four survey rounds, mothers were given a quiz of 10 questions relating to nutrition. The purpose of this was to obtain an empirical measure of each mother's nutritional knowledge, which could then be entered in the regression estimations to test whether specific knowledge in the area of nutrition affected the efficient use of household resources, especially as compared with the effect of years of formal education.

From the total of 40 questions, 17 that split the correct and incorrect answers into two fairly even groups were selected. A nutritional knowledge score, equivalent to the number of correct answers given, was calculated for each mother. These scores ranged from 1 to 17 with an overall population mean of 7.5 and were highly correlated with mothers' education (see Table 2).

Z-Score Estimations

In the fourth and final link specified in Chapter 3, weight-for-height (a short-run measure of nutritional status) was regressed on preschooler calorie intakes (Table 25). Preschooler intakes were found to be a positive and significant determinant of weight-for-height for the whole sample and for the corn-household and sugar-household subsamples. While it should be pointed out that the magnitudes of Z-score elasticities are sensitive to population means, which can approach zero, the estimated elasticities calculated from the coefficients on preschooler calorie intakes are 0.39, 0.34, and 0.57 for the whole sample and corn-household and sugar-household subsamples, respectively. Greater calorie intakes mean better nutrition in the short run and presumably in the long run also if these intakes can be sustained over longer periods.

Morbidity, as represented by zero-one dummy variables for diarrhea and fever, is negatively and significantly associated with short-run nutritional status for the whole sample and for sugar households. If these occurrences of sickness continue repeatedly over the long run, the higher morbidity levels for sugar-household children are a major contributor to the more rapidly declining height-for-age Z-scores for sugar-household children as they grow older.

The F-statistic, computed to test the equality of the coefficients between the corn-household and sugar-household subsamples, was significant. This result was more or less expected, given the different morbidity rates between the groups and the more rapidly declining height-for-age Z-scores for sugar-household children.

Summary

With the analysis of all four links between income and nutritional status completed, as outlined in Chapter 3, it is possible to estimate the effect of changes in income on the

Table 25—Regression results for the relationship between preschoolers' calorie intake and weight-for-height

Variable	All Households		Corn Households		Sugar Households	
(Constant)	−2.80493	(−3.17)	−3.41129	(−2.82)	−1.06934	(−0.65)
PCALAEQ	1.0775×10^{-4}	(3.90)*	9.6935×10^{-5}	(2.62)*	1.5494×10^{-4}	(3.05)*
DIARR	−0.52031	(−3.62)*	−0.17917	(−0.90)	−0.79902	(−3.59)*
FEVER	−0.22818	(−3.44)*	−0.06216	(−0.68)	−0.33448	(−3.04)*
MNTHBFED	2.4400×10^{-3}	(0.77)	-5.844×10^{-3}	(−1.28)	0.01162	(2.28)*
BRTHSP1	-4.406×10^{-3}	(−3.62)*	-2.851×10^{-3}	(−1.89)	-7.761×10^{-3}	(−2.84)*
MOTHED	0.02909	(2.50)*	0.02247	(1.42)	0.05561	(2.77)*
FATHED	−0.01673	(−1.66)	−0.03022	(−2.02)*	-2.062×10^{-3}	(−0.13)
MOTHAGE	1.4876×10^{-3}	(4.45)*	1.1664×10^{-3}	(2.73)*	1.6346×10^{-3}	(2.64)*
NUTRSC1	-5.475×10^{-3}	(−0.65)	-4.256×10^{-3}	(−0.40)	−0.01784	(−1.16)
CHILDCRE	-4.263×10^{-4}	(−1.72)	-3.577×10^{-4}	(−1.10)	-7.576×10^{-4}	(−1.77)
SEX	−0.15879	(−3.13)*	−0.11764	(−1.73)	−0.26390	(−2.96)*
HTFATH	-2.294×10^{-3}	(−0.53)	2.8451×10^{-3}	(0.45)	-8.935×10^{-3}	(−1.28)
HTMOTH	0.01455	(3.97)*	0.01453	(3.60)*	8.4126×10^{-3}	(0.90)
RD1	−0.09839	(−1.40)	−0.07415	(−0.80)	−0.04898	(−0.40)
RD2	−0.14613	(−2.06)*	−0.16582	(−1.75)	−0.07918	(−0.67)
RD3	−0.06536	(−0.91)	−0.09738	(−1.02)	0.08283	(0.68)
	R^2 =	0.115	R^2 =	0.089	R^2 =	0.231
	F =	7.91	F =	3.07	F =	6.20
	N =	995	N =	522	N =	347

Notes: The dependent variable is weight-for-height. t-statistics are in parentheses.
*Significant at the 0.05 level.
Definitions of variables:

PCALAEQ = preschooler calorie intake per adult-equivalent per day;
DIARR = zero-one dummy for diarrhea reported in past two weeks;
FEVER = zero-one dummy for fever reported in past two weeks;
MNTHBFED = months that child was breastfed before stopping;
BRTHSP1 = months between births of present and previous child;
MOTHED = years of formal education of the mother;
FATHED = years of formal education of the father;
MOTHAGE = age of the mother in months;
NUTRSC1 = measure of the nutritional knowledge of the mother;
CHILDCRE = minutes spent in child care in previous 24 hours;
SEX = 0 = female, 1 = male;
HTFATH = height of the father in centimeters;
HTMOTH = height of the mother in centimeters; and
RD1,RD2,RD3 = zero-one dummy variables for round.

short-run nutritional status of preschoolers via the higher calorie intakes that higher incomes make possible. The short-run nutritional status-income elasticity (that is, with respect to weight-for-height) for the whole sample may be estimated by multiplying the individual elasticities for each link: (0.65) (0.17) (1.18) (0.39) = 0.05, implying that a doubling of income improves weight-for-height by only 5 percent. This 5 percent difference for every 100 percent increase in income does not show up clearly across expenditure quintiles in Table 21 (see weight-for-height Z-scores for three- and four-year-olds) because of the confounding effect of higher morbidity rates of preschoolers in higher-income sugar households.

What benefit the extra calories provide at higher incomes is negated to some extent by these higher morbidity rates, so that (once breastfeeding has been stopped, on average after 14 months of age) the net effect of income on nutritional status in the short run is negligible in the two-way table.

Note in Table 21 that the height-for-age values in the lowest and highest expenditure quintiles remain almost unchanged for preschoolers aged one to four years. This implies that most of the improvement in height-for-age that is derived from income is realized before the preschooler's first birthday—most likely in the form of better maternal nutrition during pregnancy and breastfeeding. Weaning takes an especially high toll on the heights of higher-income preschoolers (relative to NCHS standards). After that, as preschoolers grow older, the relationship between income and height-for-age remains almost unchanged. This is consistent with the finding of a very low correlation between income and short-run nutritional status.

8

CONCLUSIONS

This research has had two objectives: examining the process of commercialization in order to generalize as to the key factors in favorable or unfavorable nutritional outcomes, and addressing policy concerns that are specific to the Philippines. Accordingly, some of the conclusions and policy recommendations that come out of this study are relatively narrow in focus, applying only to the Philippines, Mindanao, or perhaps only the study area itself. Others are more widely applicable, both in terms of methodologies that were tried and could possibly be replicated in other studies of nutrition policies, and in identification of the key factors mentioned above that may manifest themselves in similar ways in the other IFPRI commercialization studies.

Production Policies

The analysis of the profitability of corn production for a group of smallholder producers in a traditional corn-growing area shows that productivity is so low that in many instances corn tenants would realize higher incomes by working in the agricultural labor force (assuming employment were available) rather than on their farms. Corn landowners do only a little better than tenants because they do not pay a share of their harvest for rent.

Declining soil fertility is a major problem. There would appear to be high returns to developing low-cost technologies for improvement of soil fertility and to investing in extension programs for dissemination of these technologies to farmers. Adoption rates of hybrid varieties of corn are low, probably because of the risk involved and high input costs. Open-pollinated varieties that do not require such high input levels have been more widely adopted. Fertilizer is being used at levels well below those that would maximize profits.

Surprisingly, in view of a widespread perception of a failing sugar industry in the Philippines, sugar production in Bukidnon is more profitable than corn production. Smallholders who kept their land were able to raise their incomes by switching from corn to sugar production. Sugar looks highly profitable in part because it is being compared with corn. Average returns of P4,500 per hectare per year (US$225 on a variable cost basis without valuing family labor and without subtracting interest on loans) are not high in an absolute sense, considering the risks involved and the amounts of capital invested. If the peso had not been devalued by 50 percent in 1984, prices received by sugar producers would have been much lower in the 1984/85 milling seasons, substantially reducing net returns.

Because transportation costs are such an important determinant of profitability, it can be presumed that many sugar producers in Negros, whose farms are at some distance from the mills, have had to discontinue production with declining sugar prices, while those nearer to the mills are able to continue production at a profitable rate but using fewer inputs, including labor. Underemployed or laid-off workers must look for employment elsewhere, but where sugar is virtually the only industry, there is no other employment. This is not the case in Bukidnon, whose agricultural economy is much more diversified.

Despite the higher profits possible from sugar production, all sugar households continued to produce some corn, on average well above what was needed for home consumption. This is probably due to their unwillingness, in case the harvest should fail or they were not able to market their crop, to bear the risk of converting entirely to cash crop production. Because these unfavorable outcomes did not in fact materialize, they were left with large surpluses of corn that could then be marketed.

Nutrition Policy for Agricultural Households

Raising household incomes appears to be a necessary but not a sufficient condition for substantially improving preschooler nutrition. Regressions show calorie intakes of preschoolers to be positively and significantly related to their nutritional status. Yet higher-income households choose to purchase nonfood items and higher-priced calories at the margin, while preschoolers continue to consume well below recommended intakes. Surely education has some role to play in convincing parents to adjust food-expenditure behavior by purchasing less-expensive sources of calories and to distribute the extra calories more equitably among household members.

For the whole sample, after controlling for income or for variables highly correlated with income such as food expenditures and household calorie intakes, the number of years of formal education of the mother was positive and significant in three of the links in the four-step system that was estimated. However, on average, mothers had received only six years of primary school education. This suggests that investments in education at the secondary level could have an important lagged effect after students marry, apart from any benefits derived from the higher incomes that better education would generate.

At the crucial second link in the four-stage process, where much of the "leakage" occurs when increases in income are not translated into increases in preschooler calorie intakes, no measure of education, knowledge, or experience is significant. It is possible that mothers are targeting more-expensive nutrients such as proteins. It is important to point out, however, that relatively modest increases in *absolute* annual per capita income (US$185 between the lowest and highest expenditure quintiles in Table 15) result in substantial increases in household calorie intakes, a point that can easily be overlooked in focusing on the low calorie-income elasticity estimates.

Improvement of preschooler calorie intakes, however, is not a sufficient condition for substantially improving nutritional status because of the high prevalence of sickness, even among high-income groups. Reducing sickness may require both education and improved community-level health and sanitary conditions.

To the extent that the findings of low calorie intakes and sickness as the primary causes of preschooler malnutrition can be corroborated by other studies in rural areas—especially for households that appear to be able to purchase more calories without substantially increasing food expenditures—a priority area of action would be to introduce pilot nutrition education programs in an attempt to determine whether food expenditure behavior and intrahousehold distribution of calories could be altered by such programs. At the same time, the major determinants of sickness need to be identified so that effective policies for reducing morbidity can also be pilot-tested and then implemented on a wider scale.

Winners and Losers

Who benefited from the introduction of sugar? An important result of the study was to show that smallholders who kept their land and were able to switch to sugarcane production realized substantial increases in income by participating in export cropping. This was accomplished despite the absence of government extension programs to teach farmers how to grow sugar, of government credit programs to help farmers with the much higher fixed costs of initiating sugarcane production, and of a government program to ensure that smallholders got growing contracts with the mill.

Land values in the areas close to the mill rose, so that small landowners who held on to their land realized substantial increases in their net worth. Higher profits from sugar production meant that these households could eat more varied diets, provide a better education for their children, enjoy better housing, and gain many other benefits that usually accrue with higher income. Pregnant and lactating mothers were able to spend less time in agricultural production and more time with their children, resulting in better nutrition for younger preschoolers.

The one negative aspect for these households from a nutritional point of view was that as preschoolers got older, they were not able to sustain their initial height gains, so that by the time they reached four years of age they were no taller than their corn-household counterparts. Despite the higher incomes of their parents, sugar-household preschoolers were eating no better than corn-household children and were getting sick more often.

Unfortunately, the numbers indicate that for every two sugar owner and sugar renter households that benefited in the ways just mentioned, there was one household that lost access to land and consequently experienced a decline in income. Thus a substantial number of households were losers in the process of commercialization studied here. By the time they reached the age of four years, preschoolers in these households could be expected to be significantly more stunted than if the households had maintained their access to land and continued to grow corn.

Data from both the presurvey and the detailed household survey indicate that it was the smallholders with relatively large landholdings who were able to overcome the barriers to adoption and initiate sugarcane production. What were the underlying factors that caused the apparent deterioration in land-tenure patterns and a more skewed distribution of income?

First, declining corn productivity constitutes a force that in a sense "pushes" landowners and tenants off the land. Returns to household labor and other inputs are quite low, making the decision to leave the land much easier in times of financial hardship. Second, the better ability of the larger farm households to bear risk, their better access to credit facilities, and their generally better education, know-how, and access to important political and social institutions put these households in a much better position to take advantage of new agricultural production technologies when they become available. Especially if these new technologies have economies of scale, but also if they are neutral to scale, these advantages of the larger farm households constitute a force that "pulls" less well endowed households off the land.

Development Strategy for Mindanao Agriculture

There are several reasons why export cropping has expanded more rapidly in Mindanao than in other parts of the country. First, it is out of the path of typhoons.

Second, the relatively even year-round distribution of sunshine and rainfall found in Mindanao is more conducive to agricultural production throughout the year than the heavy monsoon rains followed by a relatively long dry season in Luzon. Third, Mindanao is one of the few regions of the country that contains relatively large areas of arable land at higher elevations. This elevation is important for the production of some export crops, such as some vegetables (which are shipped to Manila during the rainy season in Luzon) and coffee. Fourth, population densities are lower in Mindanao than in Luzon, so that in the past there was some open land for expansion. Mindanao is well situated, then, for generating the high agricultural growth rates that policymakers at the highest levels continue to insist will be the backbone of the economic recovery in the Philippines (Lim 1987). The question is the manner in which this potential will be tapped.

The introduction of sugar in southern Bukidnon provides some important lessons for how *not* to pursue development of export cropping in the future. From the outset, most of the milling capacity of BUSCO was met by sugarcane produced on large-scale haciendas. Small-scale producers entered the scheme relatively late, and in a marginal way in terms of the total mill output. About half of small-scale sugar producers surveyed had no grower contracts with the mill and so had to strike individual deals with those who had contracts, reducing their income from sugar. Because there were relatively few small-scale sugar producers, the increases in income that these households realized provided a relatively weak stimulus to the local economy. The decreased incomes of those households that lost access to land can be presumed to have had negative multiplier effects on the local economy.

What should be done instead? First, to help to prevent a further deterioration in land distribution patterns, smallholder corn productivity needs to be improved (Rosegrant et al. 1987).[3] Both open-pollinated and hybrid varieties are available, but typically only larger landowners in Bukidnon are experimenting with the new corn technologies. A corn technology dissemination program similar to the well-known Masagana 99 program for rice has been in effect for some time. However, it has not received nearly the resources or the attention that the rice program did in the 1970s. Such a program would assist not only households that traditionally grow corn as their primary crop, but smallholder export crop producers as well. The Bukidnon surveys revealed that no households were willing to completely forgo corn production.

Second, the government needs to make a conscious effort at the same time to develop the inevitable expansion of export cropping in Mindanao on a smallholder basis. This involves reducing the barriers to entry by providing smallholders with credit and know-how through extension and by actively promoting their access to processing and marketing facilities where necessary. Although such characteristics unfortunately do not always coincide with high output prices and low production costs, all else being equal the government should seek to promote export crops that are labor intensive, have diseconomies of scale in production, have low transportation costs in marketing, and can be stored for relatively long periods after harvesting.

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[3] The analysis presented in this report supports such a policy conclusion based on distributional grounds, helping the rural poor. Rosegrant and Gonzales (Rosegrant et al. 1987) reach a similar policy conclusion taking a macro perspective—comparing costs and returns to production of various cereal and export crops in the Philippines using a domestic resource cost methodology. A strategy of promoting new corn technologies, therefore, could lead to higher growth and better distribution of income if steps were taken to overcome the barriers to adoption for smallholders.

APPENDIX 1

SHOULD THE MODEL BE TREATED AS SIMULTANEOUS OR RECURSIVE?

It is impossible to treat the four-equation model as a simultaneous system, because the data for the first two equations are specified at the household level and for the second two at the individual level. Assuming that all four equations were specified at the same level of disaggregation, it can be shown that each equation satisfies the order and rank conditions for identification of structural coefficients. Let the model be written as follows:

Equation	Y	FE	HC	PC	Z	M	F	MA	FA	NU	PK	PR	AD	PH	PD
1	b_{11}	1				a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}	a_{110}
2		b_{22}	1			a_{21}	a_{22}	a_{23}	a_{24}	a_{25}	a_{26}	a_{27}	a_{28}	a_{29}	a_{210}
3			b_{33}	1		a_{31}		a_{33}		a_{35}			a_{38}		
4				b_{44}	1	a_{41}	a_{42}	a_{43}		a_{45}					

Equation	CC	SK	SX	A	A^2	RP	HF	HM	D	FV	MB	BS
1												
2												
3	a_{311}	a_{312}	a_{313}	a_{314}	a_{315}	a_{316}						
4	a_{411}		a_{413}				a_{417}	a_{418}	a_{419}	a_{420}	a_{421}	a_{422}

where the correspondence to the codes in Appendix 3 is

Y = YPCPWK
FE = FFEXWKPC
HC = HCALAEQ
PC = PCALAEQ
Z = ZHA, ZWA, ZHA
M = MOTHED
F = FATHED
MA = MOTHAGE
FA = FATHAGE

NU = NUTRSC1
PK = PRCORN
PR = PRRICE
AD = ADEQVHH
PH = PCTHOME
PD = POPDEN
CC = CHILDCRE
SK = SICK
SX = SEX

A = ACCAGE
A^2 = AGESQ
RP = RATIOPAR
HF = HTFATH
HM = HTMOTH
D = DIARR
FV = FEVER
MB = MNTHBFED
BS = BRTHSP1

The coefficients on endogenous variables are denoted as b and those for predetermined variables are denoted as a.

Applying the *order* condition to each equation (comparing the number of predetermined variables excluded from the equation and the number of endogenous variables in the equation minus one), it can be seen that each equation is overidentified. The sufficient *rank* condition (is the matrix, constructed from the columns of the variables not included in the equation, of full rank?) also demonstrates overidentification of each equation.

An alternative is to break the model up into two simultaneous subsets that are recursive with respect to each other. The FE and HC equation pair would be one subset and the PC and Z equation pair the other. This would prove unsatisfactory, as the first subset would be underidentified, and even more arbitrary zero restrictions would have to be imposed on both the FE and HC equations.

A strong case can be made for recursive estimation in this situation. In relation to equation 1, a sufficient condition for the separability of production and consumption of semisubsistence households is that all markets exist for commodities that are both produced and consumed by the household, including leisure, with the household being a price-taker in each one. Evidence for the efficient functioning of the study area corn market is provided in Chapter 5, and there is some additional circumstantial evidence to suggest that market imperfections are not significant (Haddad and Bouis 1989). Thus income can be included as a right-hand side variable in the first equation without too much trepidation.

In relation to equations 3 and 4, it is unlikely that calorie intake and weight are simultaneously determined, simply because the body takes time to assimilate calories and other nutrients. For equation pairs 1 and 2, and 2 and 3, the theoretical arguments for recursiveness are weaker. Nevertheless, right-hand side exogeneity is tested for in all equations with a Hausman Test, and where necessary an equation-by-equation instrumental variable estimation is applied.

APPENDIX 2

TOTAL EXPENDITURES AND HOUSEHOLD CALORIE AVAILABILITY AS PROXIES FOR INCOME AND HOUSEHOLD CALORIE INTAKES

Table 15 in Chapter 6 presents data for income, total expenditures, food expenditures, calorie availability, and calorie intakes disaggregated by income quintile, total expenditure quintile, and crop and tenure group. While regression analysis is necessary to obtain more refined estimates that take account of a number of variables not shown, this two-way table nevertheless provides a rough indication of the magnitude of the relationship between income and household calorie intakes. In analyzing this relationship, a number of methodological issues need to be raised, which the two-way table helps to bring into focus.

The Relationship Between Income and Total Expenditures

While total expenditures plus savings should theoretically sum to income, how do the data for these two variables actually compare? On average for the total sample, per capita income is somewhat less than per capita total expenditures.

If savings are positive, income should be higher than expenditures. In calculating *income*, all agricultural production was valued at farmgate prices, whether sold or kept for home consumption. In calculating *food expenditures*, agricultural production consumed at home was valued at retail prices. Valuing consumption of own-produced food at retail prices instead of farmgate prices in the income calculation would have resulted in higher incomes. For example, implementing this alternative accounting system for a household earning two-thirds of its income from own-farm production, which kept half of its total production for home consumption, and where the markup between retail and farmgate prices was 25 percent (numbers not untypical for corn share tenant households) would give an estimate of income that was a minimum of 8 percent higher (profits go up by more than 25 percent, the percentage depending on the difference between the output price and production costs).

Comparing incomes and total expenditures for the various crop-tenancy groups given in Table 15, there is the expected strong association between the two variables, with savings indicated for the higher-income groups and accumulation of debts for the lower-income groups. While this pattern of savings and debts may actually have occurred over the particular survey period, the accumulation of debts obviously cannot occur indefinitely. An alternative interpretation is that certain socially obligatory income transfers to extended family members or other dependents are perhaps easy to pick up on the expenditure side, but not on the income side, for net "debtors" (low-income groups), and are picked up on the income side, but not on the expenditure side, for net "lenders" (high-income groups). If this is the case, both the income and expenditure data are biased, with income data underestimated at the low end of the distribution and expenditure data underestimated at the high end.

Using Income and Expenditures to Classify Households

In order to obtain a rough estimate of the income elasticity of household calorie consumption from Table 15 as an intuitive check against regression results presented in

Chapter 6, what is the dispersion in incomes and expenditures between low- and high-income groups? Disaggregating by *income* quintile in this two-way table, incomes increase by a factor of 7.7 from the first to fifth income quintile, while factors for total expenditures and food expenditures are only 2.5 and 2.0, respectively. Disaggregating by *expenditure* quintile, these three factors are 4.0, 4.1, and 3.0, respectively. In the second calculation, income dispersion goes down, while expenditure dispersion goes up. Which of these conflicting results is to be believed?

Any disaggregation of a continuous variable into equal groups by a monotonic ranking of *itself* will likely overstate the actual dispersion calculated as above. This is because randomly distributed overestimates of the variable tend to be filtered to one side of the distribution and underestimates to the opposite side.[4] This is a particular problem at the tails, while for middle groups overestimates and underestimates will tend to even out (note in Table 15 that for both the *third income* and *third expenditure* quintiles, estimates of income, total expenditures, and food expenditures are nearly identical). Despite this, economic data are often presented and analyzed in this manner; for example, total expenditure data by expenditure decile.

What is perhaps more common is the presentation and discussion of the dispersion of a second variable, which is correlated with and ranked using the first variable; for example, rice consumption by expenditure decile (assume that rice consumption data are collected independently of the total expenditure data and are not used in the calculation of total expenditures). The dispersion of the second variable (rice consumption) will be *understated* to the extent that there are errors in measuring the first variable.

To see this, assume that two data sets are available, one with perfectly measured estimates of total expenditure and rice consumption (which generate accurate estimates of rising rice consumption for each successively higher expenditure decile), and a second data set identical to the first, except that the expenditure data are replaced by numbers randomly generated from a normal distribution with the same mean and variance as the original expenditure data. Given a large enough sample, average rice consumption for all 10 expenditure deciles computed from this second data set should be equal. As observations are gradually added from the second data set to contaminate the first data set, the dispersion in rice consumption computed from the combined data set will gradually decline and give an estimate lower than the true value.

This example provides a framework, then, for an intuitive understanding of the different patterns of dispersions obtained above when disaggregating by income quintile and by expenditure quintile in Table 15. More important, however, some rules can be stated about the relative magnitudes of the biases introduced: (1) dispersion biases are smaller across classification groups in the middle of the distribution than across classification groups at the tails of the distribution; (2) dispersion biases are smaller for variables that can be measured more accurately; (3) after measuring the dispersions of two variables by stratifying by each of the variables, estimates can be obtained that "bracket" the true dispersion.

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[4] In econometrics, a well-known result is that errors in measuring a variable will lead to estimates that are biased toward zero. In computing elasticities from dispersions observed in two-way tables, the greater dispersion caused by measurement errors when a variable is classified by itself results in a larger denominator, which biases the elasticity estimate toward zero. As the discussion goes on to point out, this is reinforced by an understatement of the dispersion of the correlated variable, which appears in the numerator of the simple elasticity calculation.

By making use of rule 1 to illustrate the use of rule 3, ratios of income and total expenditures for the fourth and second income quintiles and the fourth and second expenditure quintiles are computed and shown in Table 26.

Between the second and fourth income/expenditure quintiles, then, incomes increase between 77 and 91 percent and total expenditures increase between 34 and 68 percent. Since expenditures can be measured more accurately than income, using rule 2, the income increase is closer to 77 percent than to 91 percent and the increase in expenditures is closer to 68 percent than to 35 percent.

Using estimates of 80 percent for the increase in income and 65 percent for the increase in total expenditures implies a marginal savings rate of about 20 centavos out of each extra peso of income. While such a marginal savings rate seems perhaps high, using percentage increases closer to those generated by the income quintile breakdown gives even higher marginal rates of saving. The expenditure quintile breakdown seems to give more reasonable estimates.

Calorie Availability Versus Calorie Intakes

In order to obtain an estimate of the numerator in the calculation of an income elasticity of household calorie consumption, what is the dispersion in household calorie consumption between the second and fourth income/expenditure quintiles? According to the rules above, the dispersion estimates of calorie availability or calorie intakes by income quintile or by expenditure quintile in Table 15 all understate the true dispersion. Nevertheless, since expenditure data are measured more accurately, expenditure quintiles should give a better indication.

Empirically, the selection between the two data sources for calories turns out to make much more difference than the selection of income or expenditure quintiles. The calorie availability data indicate percentage increases of 19.0 percent and 2[illegible]4 percent for income and expenditure quintiles, respectively, and the calorie intake data indicate percentage increases of only 4.7 percent and 5.4 percent for income and expenditure quintiles, respectively (see Table 26). Which data source is more accurate?

Table 26—Income elasticities of household calorie consumption implied by the two-way relationship between income and household calorie intakes

Categories Across Which Elasticities Are Calculated	Ratio of Incomes	Ratio of Total Expenditures	Ratio of Calorie Availability	Ratio of Calorie Intakes	Implied Elasticity: Income: Calorie Availability	Implied Elasticity: Income: Calorie Intake	Implied Elasticity: Total Expenditures: Calorie Availability	Implied Elasticity: Total Expenditures: Calorie Intake
Fourth and second income quintiles	1.890	1.314	1.180	1.052	0.20	0.06	0.57	0.17
Fourth and second expenditure quintiles	1.803	1.677	1.244	1.066	0.32	0.07	0.36	0.10
Corn-owner and corn-laborer households	1.793	1.523	1.079	1.026	0.10	0.03	0.15	0.05
Sugar-owner and sugar-laborer households	2.645	2.091	1.202	1.067	0.12	0.04	0.19	0.06

Note: The two-way relationship is presented in Table 15.

In a comparison of the two data sources for the eight crop-tenancy groups, for six of the groups calorie availability and calorie intakes are within 3 percent of each other. For the two highest-income crop-tenancy groups, sugar owners and sugar owner/renters, however, calorie availability exceeded calorie intakes by 11 percent and 29 percent, respectively. Food expenditures for family consumption for these households were apparently seriously overestimated, even though questions were asked about food given to guests and to hired laborers, which was subtracted from food expenditure and calorie availability estimates. Data not shown here indicate that the most serious discrepancies between calorie availability and intakes occurred in round 3 of the survey during the height of the sugar harvest. Thus, calorie intake data would appear to be more reliable than calorie availability data.

Finally, taking 5 percent (percentage increase in household calorie intakes between the second and fourth expenditure quintiles) as the numerator of the income elasticity of household calorie consumption, and either 80 percent (percentage increase in income) or 65 percent (percentage increase in expenditures) as the denominator, gives elasticity estimates below 0.10. At average income levels for the sample households, analysis of the data from Table 15 indicates that as permanent incomes double, household calorie consumption goes up less than 10 percent. This figure is consistent with regression estimates presented in Chapter 6.

Conclusion

The presentation here has been somewhat intuitive, but the same concepts have been developed more rigorously from an econometric perspective in Bouis and Haddad 1989. The regression analysis presented there gives very similar elasticity estimates to those developed in Table 26.

An important objective of this discussion has been to show that because total expenditures and calorie availability are both constructed from food-expenditure data, there is a strong potential for upwardly biased estimates of the relationship between total expenditures and calorie availability. Households that overestimate (underestimate) food expenditures necessarily overestimate (underestimate) total expenditures and calorie availability. Such overestimations and underestimations may be random in nature, or what is worse in the case of the data presented here, there may be a systematic bias associated with a particular income level.

The availability of income and calorie intake data, which are collected independently of food expenditures, allowed a check against the usual shortcut of using total expenditures and calorie availability. While the income and calorie intake data are admittedly difficult and expensive to collect, in this study these alternative data sources gave elasticity estimates that differed by a factor of four or five from estimates derived using calorie availability and total expenditure data.

APPENDIX 3

DESCRIPTIVE STATISTICS AND RESULTS OF F-TESTS AND TESTS FOR EXOGENEITY

Table 27—Descriptive statistics for variables used in regression analysis

Variable	Mean	Standard Deviation
Tables 16 and 18		
YPCPWK	41.72	42.30
FFEXWKPC	31.14	16.53
MOTHED	6.15	2.68
FATHED	5.59	2.94
MOTHAGE	32.94	7.40
FATHAGE	36.73	8.33
NUTRSC1	7.54	3.22
PRCORN	3.67	0.63
PRRICE	5.07	0.76
PCTHOME	38.73	25.49
POPDEN	150.04	44.89
ADEQVHH	5.25	2.12
RD1	0.25	0.43
RD2	0.25	0.43
RD3	0.25	0.43
AVNETWTH	22,651.22	46,061.88
CULTARPC	0.38	0.39
Number of observations	1,642	. . .
Table 20		
PCALAEQ	1,915.35	901.23
HCALAEQ	2,363.47	726.69
RATIOPAR	1.22	0.19
MOTHED	6.18	2.71
MOTHAGE	393.28	89.53
NUTRSC1	7.60	3.20
CHILDCRE	70.04	97.93
SICK	0.30	0.44
SEX	0.55	0.50
ACCAGE	39.16	11.92
AGESQ	1,703.12	898.67
ADEQVHH	5.22	2.06
RD1	0.27	0.44
RD2	0.24	0.43
RD3	0.24	0.43
FFEXWKPC	31.05	16.61
BRTHORDR	4.04	2.22
FATHED	5.66	2.82
Number of observations	995	. . .
Table 25		
ZHA	−2.16	1.18
ZWH	−.53	0.83
PCALAEQ	1,929.62	918.31
DIARR	0.03	0.17
FEVER	0.18	0.38
MNTHBFED	13.76	8.09
BRTHSP1	38.16	22.18
MOTHED	6.28	2.75
FATHED	5.70	2.96
MOTHAGE	398.09	82.74

(continued)

Table 27—(continued)

Variable	Mean	Standard Deviation
NUTRSC1	7.80	3.27
CHILDCRE	71.74	103.00
SEX	0.53	0.50
HTFATH	161.44	5.89
HTMOTH	150.40	6.95
RD1	0.27	0.44
RD2	0.25	0.44
RD3	0.24	0.43
FFEXWKPC	30.56	16.76
Number of observations	995	. . .

Definitions of variables:

YPCPWK = income per capita per week (LNY = ln[YPCPWK]);
FFEXWKPC = household food expenditures per capita per week (LNFFEX = ln[FFEXWKPC]);
MOTHED = years of formal education of the mother;
FATHED = years of formal education of the father;
MOTHAGE = age of the mother in months;
FATHAGE = age of the father in months;
NUTRSC1 = measure of nutritional knowledge of the mother;
PRCORN = quality-adjusted real price of corn;
PRRICE = quality-adjusted real price of rice;
PCTHOME = percent of food expenditures coming from own-farm production;
POPDEN = population density of municipality;
ADEQVHH = number of household members expressed in adult-equivalents;
RD1,RD2,RD3 = zero-one dummy variables for round;
AVNETWTH = average net worth of all household assets;
CULTARPC = average cultivated area per round;
PCALAEQ = preschooler calorie intake per adult-equivalent per day;
HCALAEQ = household calorie intake per adult-equivalent per day;
RATIOPAR = ratio of average of father's and mother's calorie intake per adult-equivalent over the household calorie intake per adult-equivalent;
CHILDCRE = minutes spent by mother in child care in previous 24 hours;
SICK = zero-one dummy for reporting sickness in previous two weeks;
SEX = 0 = female, 1 = male;
ACCAGE = age of preschooler in months;
AGESQ = age of preschooler squared;
BRTHORDR = birth order;
ZHA = height-for-age;
ZWH = weight-for-height;
DIARR = zero-one dummy for diarrhea reported in past two weeks;
FEVER = zero-one dummy for fever reported in past two weeks;
MNTHBFED = months that child was breastfed before stopping;
BRTHSP1 = months between births of present and previous child;
HTFATH = height of the father in centimeters; and
HTMOTH = height of the mother in centimeters.

Table 28—Results of testing for equality of coefficients between corn and sugar households

Table 16 (dependent variable = per capita food expenditures)

RSS for corn sample	= 135,249.30
RSS for sugar sample	= 121,713.60
RSS for combined sample	= 269,603.00
Number in corn sample	= 928
Number in sugar sample	= 624
Number of restrictions	= 14
F-statistic	= 5.35

Table 18 (dependent variable = household calorie intake per adult-equivalent)

As Estimated in Table 18		Adding Owned Area Cultivated as an Additional Regressor[a]	
RSS for corn sample	= 491,504,400.00	RSS for corn sample	= 491,493,500.00
RSS for sugar sample	= 259,865,900.00	RSS for sugar sample	= 256,795,800.00
RSS for combined sample	= 757,230,300.00	RSS for combined sample	= 754,399,700.00
Number in corn sample	= 928	Number in corn sample	= 928
Number in sugar sample	= 624	Number in sugar sample	= 624
Number of restrictions	= 14	Number of restrictions	= 15
F-statistic	= 0.85	F-statistic	= 0.83

Table 20 (dependent variable = preschooler calorie intake per adult equivalent)

RSS for corn sample	= 182,699,100.00
RSS for sugar sample	= 117,367,400.00
RSS for combined sample	= 308,102,400.00
Number in corn sample	= 587
Number in sugar sample	= 345
Number of restrictions	= 14
F-statistic	= 1.73

Table 25

(dependent variable = weight-for-height)		(dependent variable = height-for-age)	
RSS for corn sample	= 281.65	RSS for corn sample	= 559.32
RSS for sugar sample	= 200.88	RSS for sugar sample	= 343.42
RSS for combined sample	= 502.60	RSS for combined sample	= 948.37
Number in corn sample	= 522	Number in corn sample	= 522
Number in sugar sample	= 347	Number in sugar sample	= 347
Number of restrictions	= 16	Number of restrictions	= 16
F-statistic	= 2.18	F-statistic	= 2.64

Notes: RSS = residual sum of squares. Critical F-value for the various equations falls between 1.3 and 1.4 at the 0.01 level.

[a] To take account of overestimated food expenditures by sugar owner households and sugar owner/renter households.

Table 29—Results of Hausman tests for exogeneity of right-hand side variables

Table 16 (dependent variable = per capita food expenditures; tested independent variable = per capita income)

Sample Households	Identifying Variable(s)	t-Statistic for Fitted Value
All	CULTARPC, AVNETWTH	14.22
All	CULTARPC	12.67
All	AVNETWTH	12.06
Corn	CULTARPC, AVNETWTH	9.64
Corn	CULTARPC	8.06
Corn	AVNETWTH	7.13
Sugar	CULTARPC, AVNETWTH	7.20
Sugar	CULTARPC	6.73
Sugar	AVNETWTH	6.08

Table 18 (dependent variable = household calorie intake per adult-equivalent; tested independent variable = per capita food expenditures)

Sample Households	Identifying Variable(s)	Estimated as Shown in Table 18	Owned Area Cultivated Added as Explanatory Variable
All	CULTARPC, AVNETWTH	2.12	0.38
All	CULTARPC	1.42	−0.27
All	AVNETWTH	2.56	1.16
Corn	CULTARPC, AVNETWTH	−0.53	−0.55
Corn	CULTARPC	−0.62	−0.64
Corn	AVNETWTH	−0.16	−0.11
Sugar	CULTARPC, AVNETWTH	2.37	0.68
Sugar	CULTARPC	1.88	0.25
Sugar	AVNETWTH	2.47	1.01

Table 20 (dependent variable = preschooler calorie intake per adult-equivalent; tested independent variable = household calorie intake per adult-equivalent)

Sample Households	Identifying Variable(s)	t-Statistic for Fitted Value
All	FFEXWKPC	0.63
Corn	FFEXWKPC	−0.14
Sugar	FFEXWKPC	1.07
	Tested independent variable = ratio of parents' intake to household intake	
All	FATHED	1.02
Corn	FATHED	1.95
Sugar	FATHED	−1.04
	Tested independent variable = sickness of preschooler during past two weeks	
All	BRTHORDR	−0.22
Corn	BRTHORDR	0.22
Sugar	BRTHORDR	0.69

Table 25 (dependent variables = weight-for-height and height-for-age; tested independent variables = preschooler calorie intake per adult-equivalent)

Sample Households	Identifying Variable(s)	Dependent Variable Is Weight-for-Height	Dependent Variable Is Height-for-Age
All	FFEXWKPC	−0.16	2.17
Corn	FFEXWKPC	0.30	−0.71
Sugar	FFEXWKPC	−1.11	2.93

Note: Critical t-value for the various equations falls between 1.96 and 1.98 at the 0.05 level for a two-tailed test.

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HORTICULTURAL EXPORTS OF DEVELOPING COUNTRIES: PAST PERFORMANCES, FUTURE PROSPECTS, AND POLICY ISSUES

Nurul Islam

April 1990

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HORTICULTURAL EXPORTS OF DEVELOPING COUNTRIES: PAST PERFORMANCES, FUTURE PROSPECTS, AND POLICY ISSUES

Nurul Islam

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FOREWORD

Faced with increasing import requirements for accelerated growth, developing countries need to rapidly expand their export earnings. For most, agricultural exports constitute a major source of foreign exchange earnings. But traditional agricultural exports of developing countries, such as agricultural raw materials and tropical beverages, face slow growth prospects in world markets, and food exports, such as cereals, livestock products, and sugar, cannot compete with the subsidized exports of developed countries. In this context, the importance of identifying and promoting nontraditional exports with high growth prospects in world markets, such as horticultural exports, can hardly be overemphasized. Labor-abundant developing countries have or can rapidly develop comparative advantage in many horticultural exports. Moreover, the potential contribution of these products to agricultural diversification and employment expansion in developing countries is likely to be significant.

IFPRI has undertaken in the past specific studies of selected agricultural exports, including *Nontraditional Exports in Guatemala: Effects on Production, Income, and Nutrition,* Research Report 73, and *Constraints on Kenya's Food and Beverage Exports,* Research Report 44. However, little research has been done on world trade in horticultural products. This research report, which is the first comprehensive analysis of the world trade in horticultural products, includes their composition, market structure, past trends, and the role of price and nonprice factors, as well as an examination of the differential performances of developing countries and regions.

The study provides guidance on both domestic and international policy measures crucial for the realization of this dynamic sector. On the domestic front, developing countries need to strengthen their competitive position by intensifying research and development efforts on cost-reducing innovations in production, by expanding their domestic markets to realize economies of scale, and by developing efficient systems of packaging, processing, storage, transportation, and distribution.

Future export prospects also largely depend on the liberalization of trade restrictions in the developed countries. This emphasizes the critical role of the GATT negotiations now under way, especially for the liberalization of nontariff barriers, particularly the harmonization of widely divergent national sanitary and health regulations on imports.

Detailed country studies bearing on specific questions of product choice, technology, infrastructure institutions, and policy framework are needed in order to devise an appropriate strategy for the horticultural sector in developing countries.

John W. Mellor

Washington, D.C.
April 1990

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Nurul Islam

1

SUMMARY

In recent years, policymakers, analysts, and development specialists have expressed broad interest in the potential contribution of horticultural products to agricultural diversification, employment expansion, and foreign exchange earnings in developing countries. Yet little research has been done on world trade in horticultural products or on the production, marketing, and export of such products in developing countries. The data available—published or unpublished—on international trade in horticultural products as a whole or individually are limited. This report seeks to contribute to this small fund of knowledge a comprehensive analysis of world trade in fruits and vegetables (excluding such products as cut flowers, foliage. potted plants, and nursery materials), with special emphasis on the exports of developing countries. About 150 products are covered over a period of 25 years.

Given their importance, it is surprising that horticultural products have been neglected or underestimated in the past. The share of horticultural exports in world agricultural trade has risen over the years; by 1983-85, horticultural products constituted about 12 percent of world agricultural trade, next in importance to cereals, livestock products, and oilseeds, fats, and oils. At 13 percent, horticultural exports were the third largest category of agricultural exports in developing countries in 1983-85. They followed oilseeds, fats, and oils and were more important than agricultural raw materials and sugar. For a number of individual countries, horticultural exports' share of agricultural exports was more than 25 percent. Developing countries' share of world horticultural exports continued to increase during 1975-85, when the rate of growth of world horticultural trade slowed; by 1983-85, it was 37 percent, with an absolute value of US$9 billion.

The developed countries provided the largest import market, accounting for 83 percent of world imports of horticultural products during 1983-85. The developing countries' share of world import demand—17 percent—was an increase from 14 percent in 1975-77. Fast-growing import markets during 1975-85 were the United States and Japan, although the rate of growth of Japanese imports slowed compared with 1965-75. Although Western Europe had the lowest rate of growth of imports during 1975-85, it remained the largest import market in absolute size: even excluding inter-European trade, it was still about 80 percent larger than the United States market. However, the largest part of world trade in horticultural products was carried on between the developed countries themselves. They obtained 72 percent of their horticultural imports from other developed countries and sent 80 percent of their exports to these countries during the early 1980s. The developing countries sent about 20 percent of their exports to other developing countries.

The product composition of world horticultural exports has changed over time, with an increase in the relative importance of fruits since 1975. By 1983-85, fruits constituted 70 percent of the total horticultural exports of developing countries. Also, the unit value of fruits was higher than that of vegetables, and it grew faster. The developing countries' share of world exports of fruit was 42 percent in 1983-85, whereas their share of vegetables was 28 percent. At the same time, the share of processed products, especially processed vegetables, in the exports of developing countries went up. The value added in the processing of fruits and vegetables was considerable. The unit value of processed fruits was three-and-one-half times higher than that of fresh fruits, whereas the unit value of processed vegetables was twice as high as for fresh vegetables.

A variety of products were internationally traded: the most important fresh fruits were oranges, other citrus fruits, and bananas, while mangoes and avocados were the fastest-growing tropical products. Fruit juices, both tropical and nontropical, were the leading exports in the processed fruits category. The developing countries also increased their share of exports of potatoes and miscellaneous vegetables, of which tomatoes constituted 30 percent. Most products that were in competition with developed countries gained a larger share of the world market during the period 1975-85.

A limited number of developing countries dominated horticultural exports. Twelve countries accounted for 22 percent of the world market and 65 percent of the exports of developing countries in 1983-85. There was stiff and aggressive competition between them, and their relative shares of world trade shifted from time to time. The limited number of competitive countries was explained partly by the agroecological characteristics of individual countries and partly by the limited size, in many cases, of the total world market for individual commodities. No less important were obstacles to entry into export markets that resulted from the specialized nature of the export-related infrastructure, including strict quality and health standards, as well as established consumer preferences for specific products in particular markets. For products with a value of US$50 million or more, four leading exporters, each having a share of at least 5 percent of the total developing-country exports of that commodity, accounted for about 80 percent or more of the exports.

Trade restrictions in the industrial countries, including tariff and nontariff barriers, constrained the growth of exports. Fresh vegetables were subject to higher duty rates—an average of 9 percent—than fresh fruits, which averaged 5 percent, while rates of 15 percent for processed fruits and 12 percent for processed vegetables were imposed. These rates escalated with the degree of processing. Tropical horticultural products in general had lower rates of duty. The nontariff barriers were, on the whole, higher for fruits than for vegetables, with the differences between import and domestic prices ranging from 22 to 180 percent for fruits and from 30 to 80 percent for vegetables. In general, both tariff and nontariff trade restrictions were higher in Japan and the European Community than in the United States, except for processed fruits.

The success of the multinational trade negotiations under the General Agreement on Tariffs and Trade (GATT) is essential for an effective liberalization of trade in horticultural products. The tropical horticultural products are expected to receive special and early consideration in the negotiations in view of their importance to developing countries and the lack of serious competition with exports or domestic production of developed countries.

Concerning nontariff barriers, considerable importance is being attached to an international agreement under the auspices of the GATT on national sanitary standards and regulations. This should help promote harmony among importing countries and also provide a system for international surveillance, which, combined with dispute settlement procedures under GATT, should preclude possible trade-distorting effects.

Estimates of the increase in export earnings that developing countries could achieve from the elimination of trade restrictions in the European Community, the United States, and Japan vary between 6 and 9 percent over the value of exports in 1983-85, that is, between US$570 million and US$850 million. Similarly, estimates of the gains in export earnings from removal of nontariff barriers range between 24 and 36 percent, or US$2-3 billion. This is on the basis of assumed elasticities of export supply and import demand varying between 0.5 and 1.0. A large part of the additional earnings is expected to result from an increase in the world price, rather than in the volume of exports. In view of the low import penetration ratio for many horticultural products—that is, the low ratio of imports to domestic production (no more than 10 percent for horticultural products in general in any of the three major developed regions)—a significant liberalization of trade is unlikely to have any appreciable effect on domestic production.

Future prospects of horticultural exports of developing countries will depend predominantly on the growth of import demand, mostly in the developed countries. Given the high per capita consumption of fruits and vegetables today and the projected slow rates of growth of income and population in developed countries, the annual rate of growth in their aggregate domestic demand is unlikely to exceed 1.31 percent for fruits and 1.08 percent for vegetables between now and the year 2000. However, the ratio of imports to aggregate domestic demand in developed countries is estimated to increase by 28 percent for fruits and 45 percent for vegetables between now and 2000. Developed countries are expected to diversify their food consumption patterns, including consumption of horticultural products, in the future. This heightened concern with health and nutrition and familiarity with more fruits and vegetables because of wider availability, increased travel, and improved communications, will lead to an increase in the ratio of imports to domestic products in total demand. Differences in per capita consumption of fruits and vegetables among developed countries with similar patterns and levels of living may also indicate a potential for increases in import-oriented consumption in countries where consumption is relatively low at the present time.

The developing countries' share of the world import market is estimated to increase from 17 percent to only 20-23 percent by the year 2000, even though the estimated future rate of growth of domestic demand is much higher in developing countries than in developed countries. The contribution of intradeveloping-country trade to an increase in their export earnings is also likely to be small because both the volume of their current imports and the expected future import ratio are low. The same is true of the centrally planned economies; their share of world imports is estimated to increase from 6.6 percent to only 7.7 percent unless their import policy is liberalized and their per capita consumption, especially of citrus and tropical fruits, goes up significantly.

Total developing-country exports of horticultural products are estimated to increase at rates ranging from 1.6 to 3.4 percent a year and to amount in absolute value to US$12-15 billion in 1983-85 prices by the year 2000.

Export performance differs widely among countries. Limited and scattered evidence suggests that, in addition to variations in agroecological endowments, differences in labor-land productivity resulting from research and development efforts and particularly in the state of export-related infrastructure are important.

The organization of an effective system of packaging, processing, storage, transportation, and distribution, both nationally and internationally, is crucial to success in horticultural exports. Economies of scale benefit these activities by reducing their costs significantly, and this price advantage helps promote exports.

Different horticultural products have varying degrees of labor-factor intensity; therefore countries must choose appropriate commodities to take advantage of their labor endowment, including skilled labor. Also, labor intensity differs for the same product from one country to another. Ongoing research efforts in developed countries are devoted to offsetting their rising labor costs. Developing countries need to design appropriate techniques and to organize production in ways that will facilitate the linking of large-scale marketing and distribution channels with small farmers in order to take advantage of their comparatively low labor costs.

For successful export performance, a country must be first in the field, and it must carefully nurture its markets to attract consumer preferences toward its products. In addition, a large domestic market often provides both a springboard for the growth of exports and a cushion to absorb the shocks or uncertainties of export markets, except in the case of products exclusively produced for and sold in export markets.

Macroeconomic policies, especially trade and exchange rate policies that generally favor the export orientation of an economy, also help promote horticultural exports.

Detailed individual country studies are needed to analyze the factors, some agroecological and some manmade, that affect the production and exportation of horticultural products in specific circumstances. The lessons learned from their experiences will help identify the most important factors relating to institutions, technologies, and policies that contribute to an efficient horticultural sector and its success in export markets.

2

INTRODUCTION

In recent years, there has been a great deal of interest among both policymakers and trade analysts in the role of horticultural products as a principal means of agricultural diversification and foreign exchange earnings in developing countries.[1] Horticultural products have a high income elasticity of demand. As income goes up, demand rises rapidly, especially in middle- and high-income developing countries, although demand is also rising in developed countries. A growing concern for health and nutrition has caused consumer preferences to shift from high-fat, high-cholesterol foods, such as meat and livestock products, to low-fat, low-cholesterol foods, such as fish, fruits, and vegetables. Also, there is an increasing tendency in developed countries to diversify the diet by consuming a wider variety of fruits and vegetables, a change partly stimulated by the increase in international travel and communications. This in turn has led to and is facilitated by increasing imports of new and nontraditional horticultural products, especially from the tropical developing countries.

Conditions for increasing production are likely to be favorable in developing countries. This is partly because horticultural products in general are labor-intensive. Developing countries with abundant labor in relation to capital or land enjoy a comparative advantage in labor-intensive horticultural products, as against, for example, cereal products, which require more land in relation to labor and other inputs for efficient production. The growth prospects for exports of horticultural products are therefore favorable for developing countries. Horticultural products not only have good potential for generating employment in cultivation but also in processing, marketing, and distribution. And they are frequently produced on small farms, thus providing an important source of additional income for poor farmers in developing countries. There are many horticultural products, especially fruits, that fetch high prices in world trade. Thus the efficient production of high-value horticultural products on small farms can help alleviate rural poverty.

The growing interest in horticultural exports in developing countries also reflects their search for diversified nontraditional agricultural exports in order to expand foreign exchange earnings so that they can meet rising import requirements for accelerated economic growth and mounting debt service payments.

During the period 1961-85, which is considered in this study, the volume of agricultural exports grew at a rate of 2.1 percent, but imports grew by 5.8 percent, even though the rate of growth of exports accelerated during 1980-85 and imports did not grow at all. Developing countries were under pressure to expand exports and compress imports in order to meet acute balance-of-payments problems. The expansion of the volume of exports was accompanied in many cases by a fall in export prices and a slowing of growth in the value of exports. The unit value of exports fell at a rate of −1.5 percent per year during the 25-year period.

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[1] Horticultural products, in the context of this study, include fruits and vegetables as defined in the Standard International Trade Classification (SITC). Cassava is not included, but potatoes and other minor roots and tubers are. This definition also excludes such products as cut flowers, foliage and potted plants, and nursery materials. Therefore, the classification is based on the following SITC categories: 051 (fruits, fresh, and nuts, fresh or dried), 052 (dried fruits), 053 (fruit, preserved, and fruit preparations), 054 (vegetables, fresh, frozen, or simply preserved; roots, tubers, and other edible vegetable products not elsewhere specified [n.e.s.], fresh or dried), 055 (vegetables, roots and tubers, preserved or prepared, n.e.s., whether or not in airtight containers).

Many of the traditional exports of developing countries, such as tea, coffee, and cocoa, as well as agricultural raw materials such as jute, sisal, and tobacco, have been growing rather slowly, and they are unlikely to accelerate in the future. Some are faced with low price and income elasticities of demand, especially in developed countries. At the same time, exports such as sugar, livestock products, dairy products, oilseeds and oils, and pulses, face strong competition from the often-subsidized exports of developed countries.

This study seeks to determine how fast the world trade in horticultural products has grown over the past decades and to what extent the developing countries have participated in this expanding trade. It raises a number of questions in this respect. Who were the major successful exporters and in which commodities were they able to expand their exports? What was the nature of the world market in particular horticultural products? Was the market competitive, with a large number of sellers, or was it narrow and thin, with only a few exporters? Did the developing countries face much competition from developed countries in the market for horticultural products? Where were the principal markets for horticultural exports of developing countries? Was demand growing faster in developing countries than in developed countries? Was there a pattern of regional specialization among the principal horticultural exporters? Were there some discernible characteristics that contributed to the success of some countries and not others? What are the future prospects for horticultural exports? How severe are the barriers to trade they face in developed-country markets? What are the possible consequences of a liberalization of trade in the principal industrialized countries? What policy issues are relevant in formulating a strategy for the horticultural exports of developing countries?

Relative Importance of Horticultural Exports in Agricultural Trade

In analyses of world agricultural trade, not much attention has been paid to horticultural products, even though they have emerged as a major commodity group in recent years. The composition of world agricultural exports and those of developing countries during 1983-85 is shown in Table 1. Cereals and livestock products constitute the two most important groups in world trade, together about 34 percent of world agricultural exports. At 12 percent, horticultural exports (fruits and vegetables) follow closely behind oilseeds, fats, and oils, which are next in importance to cereals and livestock products. Among developing countries, horticultural exports are more important than agricultural raw materials and sugar and again follow oilseeds, fats, and oils in importance.

During the period 1965-85, the relative importance of horticultural products in world agricultural exports rose. During the first decade, world horticultural exports grew at a rate slightly below that of world agricultural exports, but in the second decade, their rate of growth exceeded that of agricultural exports. For developing countries, horticultural exports grew at a significantly higher rate than agriculture as a whole during the second decade (Table 2). In developed countries, however, the importance of horticultural exports declined throughout the period.

Although all agricultural exports, including horticultural, slowed during the second period, the growth rate of horticultural exports declined by a smaller margin than did

Table 1—Composition of agricultural exports, developing countries and world, 1983-85

Commodity Group	Developing Countries	World
	(percent)	
Tropical beverages and tobacco	24	10
Oilseeds, fats, and oils	15	13
Fruits and vegetables	13	12
Other commodities	12	20
Sugar	11	5
Raw materials	10	6
Cereals	8	17
Livestock products	7	17

Source: Food and Agriculture Organization of the United Nations (FAO), "Trade Yearbook Tape, 1985," FAO, Rome, 1986.

total agricultural exports, especially in developing countries. Furthermore, while the rate of growth of horticultural exports in developing countries was lower than that in developed countries during the first decade, it was about 40 percent higher during the second decade.

Another way of looking at the importance of horticultural exports relative to the other groups of agricultural exports of developing countries is to compare the absolute changes in the average annual values of various groups of exports (Table 3). These changes were positive for horticultural exports, whereas changes for all other single groups of agricultural exports were negative in at least one period. Moreover, the increase in the average annual value of horticultural exports compared favorably with those of other groups of agricultural exports, singly or in combination. During the first period, the annual increment of horticultural exports was significantly higher than that of sugar and tropical beverages combined or of sugar, tropical beverages, and agricultural raw materials combined. During the second period, the annual increment in horticultural exports was much higher than that of the combined values of three other agricultural exports, but less than that of the combined values of sugar and tropical beverages.

Table 2—Average growth rates of horticultural exports and all agricultural exports, 1965-75 and 1975-85

Exports/Period	World	Developed Countries	Developing Countries
		(percent)	
Horticultural exports			
1965-75	11.11	11.86	9.65
1975-85	6.44	5.50	8.26
Agricultural exports			
1965-75	12.55	13.90	10.15
1975-85	5.66	5.90	5.17

Source: Food and Agriculture Organization of the United Nations (FAO), "Trade Yearbook Tape, 1985," FAO, Rome, 1986.

Table 3—Absolute changes in the average annual value of exports, 1977-85

Commodity Group	1977-79 to 1980-82[a]	1980-82 to 1983-85[a]
	(US$ million)	
Sugar	+ 3,017	− 1,149
Tropical beverages	− 2,179	+ 1,355
Agricultural raw materials	− 281	− 177
Sugar and tropical beverages combined	+ 835	+ 206
Sugar, tropical beverages, and agricultural raw materials combined	+ 557	+ 29
Horticultural products	+ 2,529	+ 85

Source: Based on data from Food and Agriculture Organization of the United Nations (FAO), *Commodity Review and Outlook,* various issues.

[a] Three-year averages are used to iron out the effects of year-to-year fluctuations. Annual average figures for 1977-79 are compared with those for 1980-82; annual average figures for 1980-82 are compared with those for 1983-85.

Horticultural Exports of Developing Countries

During 1983-85, horticultural exports constituted about 12 percent of total world agricultural exports, amounting in value to about US$24.8 billion. The share of horticultural exports in total agricultural exports of the developing world continued to increase from about 9 percent in 1961-63 to 13 percent in 1983-85, with a slight decline between 1970-72 and 1975-77.

Meanwhile, the developing countries' share of world horticultural exports increased from 33 percent during 1961-63 to 37 percent during 1983-85. In fact, the share remained more or less constant from 1961-63 to 1975-77; the principal increase took place between 1975-77 and 1983-85. Two points need to be emphasized. First, the share of developing countries in world horticultural exports expanded even when the rate of growth of world horticultural trade slowed during the second decade. Second, the share of developing countries in world horticultural exports increased, while their share in world agricultural exports as a whole declined (Table 4).

Among the developing countries, Latin America was by far the most important region, accounting for 16 percent of world horticultural exports and 44 percent of the agricultural exports of developing countries (Table 5).[2] Near East and Far East were the next most important exporting regions in that order, each accounting for about 7 percent of world horticultural exports. Africa had the smallest share, about 3 percent, although it held 8 percent of the world market in 1961-63. While the share of all the other regions increased over time, Africa's declined; between 1975-77 and 1983-85, the nominal value of Africa's horticultural exports also declined slightly. The two regions with an accelerated rise in their market share, especially during 1975-77 and 1983-85, were Latin America and Far East: their horticultural exports increased faster than the average rate for all developing countries, with Latin America having a slight edge over Far East.

The percentage of horticultural exports in total agricultural exports in Latin America rose from 8 percent in 1961-63 to 13 percent in 1983-85 and in Near East from 18 percent to 35 percent. Far East also increased its share of horticultural products from 5 percent to 9 percent, though the absolute value of its horticultural exports was less

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[2] A list of the developing countries included in each region is presented in the notes to Table 5.

Table 4—Developing countries' share of horticultural and agricultural exports, 1961-85

Share	1961-63	1975-77	1983-85
		(percent)	
Share of developing countries in world horticultural exports	33.17	32.04	36.68
Share of horticultural in total agricultural exports of developing countries	8.94	10.44	13.03
Share of developing countries in world agricultural exports	41.00	34.20	33.00

Sources: Food and Agriculture Organization of the United Nations (FAO), "Trade Yearbook Tape, 1985," FAO, Rome, 1986; and data on horticultural products compiled by the author from various FAO sources.

Table 5—Value and share of agricultural and horticultural exports of developing countries, by region, 1983-85

			Horticultural Exports		
Developing Countries/ Region	Agricultural Exports	Horticultural Exports	Share of World Horticultural Exports	Share of Total Agricultural Exports	Rate of Growth, 1975-85
	(US $ billion)			(percent)	
All developing countries, including Asian centrally planned economies	69.7	9.1	36.7	13.0	8.3
Asian centrally planned economies	5.5	1.1	4.6	20.5	6.8
Developing market economies	64.2	8.0	32.1	12.4	8.6
Africa	8.5	0.6	2.6	7.5	-0.1
Latin America	30.9	3.9	15.6	12.5	10.8
Near East	5.2	1.8	7.3	35.3	7.2
Far East	19.1	1.6	6.6	8.6	10.2
Other developing market economies	0.5	0.1	0.0	1.6	5.8

Source: Food and Agriculture Organization of the United Nations (FAO), "Trade Yearbook Tape, 1985," FAO, Rome, 1986; and data on horticultural products compiled by the author from various FAO sources.

Notes: The following countries are included in each region. Africa: Algeria, Angola, Benin, British Indian Ocean Territory, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Djibouti, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, St. Helena, Sao Tomé and Principe, Senegal, Seychelles, Sierra Leone, Somalia, Spanish North Africa, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zaire, Zambia, and Zimbabwe.

Far East: Bangladesh, Bhutan, Brunei, Burma, East Timor, Hong Kong, India, Indonesia, Republic of Korea, Laos, Macau, Malaysia, Maldives, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, and Thailand.

Latin America: Anguilla, Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland (Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Christopher and Nevis, St. Lucia, St. Vincent Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, U. S. Virgin Islands, Uruguay, and Venezuela.

Near East: Afghanistan, Bahrain, Cyprus, Egypt, Gaza Strip (Palestine), Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Oman, Qatar, Saudi Arabia, Sudan, Syria, Turkey, United Arab Emirates, Yemen Arab Republic, and Yemen Democratic Republic.

Asian centrally planned economies: China (excluding Taiwan), China (Taiwan province), Kampuchea (Democratic), Korea (Democratic People's Republic), Mongolia, and Viet Nam.

Table 6—Ratio of exports to domestic output in horticultural products and growth rates of production and exports, developed and developing countries, 1961-85

Country Group	Share of Domestic Output Exported			Production Growth Rate		Export Growth Rate	
	1961-63	1975-77	1983-85	1965-75	1975-85	1965-75	1975-85
				(percent)			
Developed countries, including Eastern Europe and U.S.S.R.	3.36	5.36	6.29	0.42	0.45	3.49	2.85
Developing countries, including Asian centrally planned economies	2.58	2.84	2.92	3.24	2.02	3.59	2.93

Source: Data on horticultural products compiled by the author from various FAO sources.

than 50 percent of that of Latin America and 10 percent less than that of Near East in 1983-85. In agricultural exports, Latin America was the largest exporter followed by Far East, Africa, and Near East in that order.

The increase in world horticultural exports resulted partly from an increase in the domestic production of horticultural products and partly from a rise in the share of domestic output that was exported. Developed countries diverted an increasingly larger proportion of their domestic output to the export market than did developing countries. The share of domestic output exported in developed countries was almost double that in developing countries. The main source of growth in exports in developing countries was the rise in domestic output.

The growth rates of both domestic production and exports were higher in developing countries than in developed countries (Table 6). Rapidly rising domestic demand in developing countries was met by rapidly rising domestic production; the proportion of output that was exported was low. As the growth rate of production in developing countries slowed during the second decade, the growth rate of exports also slowed.

Increasing production and export of horticultural products were not, however, accompanied by a rising share of horticultural output in either food production or total agricultural production. The growth rates of food and total agricultural production were higher than that of horticultural production in both developed and developing countries (Table 7). The change in the composition of global demand in favor of horticultural products, both domestic and exported, was not strong enough to cause a rise in the share of horticultural production in total agricultural or food production.

Table 7—Annual growth rates of production, developed and developing countries, 1975-85

Country Group	Horticultural Production	Food Production	Agricultural Production
		(percent)	
Developed countries, including Eastern Europe and U.S.S.R.	0.45	1.45	1.40
Developing countries, including Asian centrally planned economies	2.02	3.28	3.32

Source: Data on horticultural products compiled by the author from various FAO sources.

3

MAJOR PRODUCTS, EXPORTERS, AND MARKETS

In 1983-85, fruits composed 61 percent of the horticultural exports of the world and 70 percent of those of developing countries. Fruits have become relatively more important in recent years, as evidenced by the higher average annual growth rate for exports of fruits than of vegetables in 1975-85 compared with 1965-75.

	Fruits	Vegetables
	(percent)	
1965-75		
Developing countries	6.57	11.39
World	10.29	12.53
1975-85		
Developing countries	8.51	7.67
World	8.97	6.25

Developing countries had a larger share of the world trade of fruits than of vegetables.

	1961-63	1975-77	1983-85
		(percent)	
Fruits	38	37	42
Vegetables	24	25	28

The share of processed products in both total world and developing-country horticultural exports increased during the period; by 1983-85, at least half of total horticultural exports were processed.

	1961-63	1975-77	1983-85
		(percent)	
World	38	44	50
Developing countries	33	47	52

Also, the share of processed vegetables in total exports of vegetables (53 percent for the world and 60 percent for developing countries) was higher than the share of processed fruits in total exports of fruits (45 and 43 percent). It is more difficult to transport fresh vegetables than fresh fruits over long distances without damage, given present systems for handling, packaging, and transporting.

In comparing the unit values of fresh, processed, and combined products in Table 8, a number of differences are evident. First, the values per ton of processed horticultural exports, both fruits and vegetables, were higher than those of fresh products, and the trend was upward over time. Second, the values of both fresh and processed fruits were generally higher than those of vegetables. Third, the differences between the

Table 8—Export unit values of horticultural products, 1983-85

Type of Production/ Country Group	Fruits	Vegetables
	(US$/ton)	
Fresh		
Developed countries	437	335
Developing countries	305	284
Total	368	315
Processed		
Developed countries	839	550
Developing countries	1,063	588
Total	919	560
Fresh and processed combined		
Developed countries	559	417
Developing countries	440	396
Total	502	411

Source: Data on horticultural products compiled by the author from various FAO sources.

values of fresh and processed vegetables were smaller than those between fresh and processed fruits. Therefore, the value added and export earnings per ton of processed fruits were higher. Fourth, the values of processed exports were higher than those of fresh for both fruits and vegetables by a wider margin in developing countries than in developed countries. The developing countries seemed to generate a higher value added per unit of processed exports than the developed countries.

The rate of increase in the unit value of vegetable exports declined significantly during 1975-85, whereas the unit value for fruits increased in developing countries (Table 9), which suggests a faster expansion in demand for fruits than for vegetables relative to supply. Growth in the quantity of fruits exported slowed, while that for vegetables accelerated. In fact, during the second decade, the rate of increase in vegetable exports was much higher (5.4 percent) than that in fruits (1.9 percent).

Detailed Composition of Fruit Trade

There are about 84 different fruits or groups of fruits traded in the world market. During 1983-85, 42 items—each with a value of US$50 million or more—amounted

Table 9—Annual growth rates of unit value and quantity of horticultural exports, 1965-75 and 1975-85

Commodity/Growth Rate	World		Developing Countries	
	1965-75	1975-85	1965-75	1975-85
		(percent)		
Fruits				
Unit value growth	6.3	4.6	4.9	6.4
Quantity growth	3.8	1.8	3.9	1.9
Vegetables				
Unit value growth	9.2	1.8	8.4	2.1
Quantity growth	3.0	4.4	3.9	5.4

Source: Data on horticultural products compiled by the author from various FAO sources.

to US$14.6 billion (96 percent of the total world trade in fruits), whereas another 42 items—each with a value of less than US$50 million—amounted to a total of US$620 million. Developing countries participated extensively in the world trade of fruits, and their trade was not confined to a few items, although shares of the trade of different items varied widely among countries, and their share in the world market of many items fluctuated over time. During 1983-85, there were only seven fruits that developing countries did not trade. A comparison of exports between 1961-63 and 1983-85 shows that developing countries began trade in many new products between the two periods. Not only did they export new items, but they also consistently increased their share of at least 20 items during the period (see Appendix 1, Tables 40 and 41).

Among the fresh fruits in world trade, the largest category in 1983-85 was that of miscellaneous fruits, followed by oranges and other citrus fruits and bananas. Among the processed fruits, the largest single category was other nontropical fruits. There were 21 different fresh fruits in the miscellaneous category. Although their share of trade increased over time, the absolute value of world exports of some of them was very small.

In the developing countries' share of the fresh fruit market, bananas remained more or less the same during the whole period and oranges rose only slightly (Table 10). The share of tropical fruits declined and miscellaneous fruits rose. The individual export items in the order of their importance were as follows: bananas, 37 percent; oranges, 12 percent; grapes, 6 percent; apples, 6 percent; hazelnuts, 5 percent; raisins, 5 percent; desiccated coconuts, 4 percent; dates, 3 percent; tangerines, 3 percent; lemons and limes, 2 percent; and grapefruits, 2 percent. Developing countries either maintained or increased their share of trade in all of these fruits over time.

Developing countries are expected to have comparative advantage in tropical fruits and, therefore, to perform well in the export market.[3] But tropical fruits constituted no more than 5.9 percent of total world trade in fresh fruits in 1983-85, increasing from 2.8 percent in 1961-63 and 3.3 percent in 1975-77. This indicates that until recently the demand for tropical fruits in industrialized countries has been limited. However, familiarity with tropical fruits is growing in developed countries as the result of, first, an increase in international travel; second, an increase in immigrants from tropical developing countries, who have created a demand for tropical foods; and third, rising affluence in developed countries, which has fostered a desire for diversification of food consumption patterns and thus a trend toward the more exotic fruits. As a result, supermarkets in developed countries are beginning to stock an increasing number of tropical fruits. However, the relative importance of tropical fruits in the world trade of fresh fruits remains very small.

Despite the recent increase in demand for tropical fruits, the share of developing countries in the world trade in tropical fruits has declined due to an increase in exports from a few developed countries that have within their territories tropical agroecological zones. The two most important categories of tropical fruit exports in which developing countries have suffered a declining trade share are mangoes and miscellaneous tropical fruits; they constituted 11 percent and 17 percent, respectively, of all tropical fruit exports during 1983-85. The share of developing countries in world trade of mangoes declined from 95 percent to 89 percent between 1975-77 and 1983-85, while that of the miscellaneous group declined from 56 percent to 39 percent (Appendix 1, Table

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[3] Included in the category of tropical fruits are mangoes, pineapples, dates, persimmons, papayas, avocados, and other fresh tropical fruits. Bananas and plantains are classified separately (FAO 1987b, FAO 1985b).

Table 10—Share of developing countries in world trade of fruits and annual growth rates, 1961-85

Fruits	Share of World Trade			Rates of Growth: World		Rates of Growth: Developing Countries	
	1961-63	1975-77	1983-85	1965-75	1975-85	1965-75	1975-85
				(percent)			
Fresh	44	39	43	9.6	7.7	5.5	6.9
Bananas	94	93	94	5.2	6.7	5.1	6.7
Oranges and other citrus fruits	30	28	32	9.8	4.6	9.1	6.6
Tropical fruits	82	66	59	11.8	13.3	11.3	11.7
Miscellaneous fruits	16	16	22	11.4	5.4	9.7	10.0
Treenuts	75	76	70	9.8	9.9	3.2	1.8
Processed	27	33	41	11.9	11.7	8.1	11.2
Nontropical juices	14	23	48	21.0	13.9	21.9	24.6
Tropical juices	25	66	60	9.5	19.2	14.9	17.8
Other nontropical fruits	17	24	27	10.0	4.9	13.6	6.6
Other tropical fruits	69	85	87	8.0	4.7	8.6	5.1
Treenuts	42	43	41	10.4	8.0	9.2	7.7
Total fruits	38	37	42	10.3	9.0	6.6	8.5

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: The fruits and products in each category are listed in the tables in Appendix 1.

40).[4] There were three specific tropical fruits—papayas, avocadoes, and dates—in which they increased their share in world trade, significantly for the first two items.

The rate of growth of all tropical fruits, except dates, continued to be high—much higher than the rate of growth of fresh fruits as a whole—partly because of their low value in the base year. With the exception of dates and papayas, the rates of growth in world trade of tropical fruits during 1975-85 ranged from 11 to 31 percent, indicating that it is possible to expand exports from developing countries, even to increase their share in world trade, if supply at competitive prices can be assured. The fastest growing tropical fruits in world trade are mangoes, avocados, and miscellaneous tropical fruits.

The fastest growing items in world trade of processed fruits in 1983-85 were fruit juices, both tropical and nontropical, which constituted 33 percent of total world trade in processed fruits in 1983-85. The share of developing countries in combined exports of tropical and nontropical fruit juices more than doubled between 1975-77 and 1983-85: developing-country shares by 1983-85 were 60 percent in tropical juices and 48 percent in nontropical. Between 1975-77 and 1983-85, exports of nontropical fruit juices from developing countries increased by 24 percent a year, compared with an annual rate of increase of 14 percent in world exports of nontropical fruit juices. Thus developing countries were able to capture an increasing share of an expanding market.

Among the nontropical juices, the most important items were orange and tangerine juices. World trade in these juices increased three-and-one-half times between the two periods, and developing countries maintained or increased their share. Developing countries already had a high share of trade in tropical juices in 1975-77 at 66 percent, but, although their exports of tropical juices increased at a rate of 18 percent a year between 1975-77 and 1983-85, their share declined to 60 percent, primarily because of a fall in their share of the pineapple juice trade.

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[4] Re-export of a few of these items may also have contributed to the fall in the share of developing countries.

In processed fruits other than fruit juices, both tropical and nontropical, developing countries increased their share between 1975-77 and 1983-85, even though their initial share of tropical processed fruits was already as high as 85 percent in 1975-77.

Detailed Composition of Vegetable Trade

There were 63 items or groups of vegetables that were traded in world markets during 1983-85, and developing countries exported all items but six. Thirty-three items, each worth US$50 million or more in world trade, constituted 95 percent of the total value of world trade in vegetables in 1983-85. Another 30 items, each less than US$50 million in value, accounted for about 5 percent of world trade. Developing countries consistently gained in their share of the market in 29 items between 1961-63 and 1983-85. In no item was there a consistent loss of share, although trade in several items fluctuated between periods (Table 11).

Among fresh vegetables, the miscellaneous vegetable category had the largest share in the value of world exports—75 percent—followed by roots and tubers at 20 percent. More than 90 percent of roots and tubers were potatoes.[5] At 28 percent, tomatoes were the most important single item in the miscellaneous vegetables category. Another 31 percent were distributed as follows: lettuce (8 percent), cucumbers (8 percent), chilies and peppers (6 percent), cabbages (3 percent), cauliflower (3 percent), and carrots (3 percent). Even though there was a decline in the growth rate of world trade in fresh vegetables overall, world trade in miscellaneous vegetables still enjoyed a higher-than-average rate of growth. During the second decade, the developing countries' share

Table 11—Share of developing countries in world trade of vegetables and annual growth rates, 1961-85

Vegetables	1961-63	1975-77	1983-85	Rates of Growth			
				World		Developing Countries	
				1965-75	1975-85	1965-75	1975-85
				(percent)			
Fresh	22	20	23	10.2	5.1	7.1	7.5
Roots and tubers	19	16	24	10.1	1.1	9.0	6.0
Hops	...	...	3	8.6	8.9	−10.9	91.0
Miscellaneous vegetables	25	22	25	10.4	6.3	6.7	7.9
Processed	26	31	32	15.2	7.3	15.4	7.8
Roots and tubers	82	10	3	18.9	18.9	2.4	3.0
Pulses	51	52	49	10.6	8.2	10.0	7.0
Miscellaneous vegetables	10	24	27	17.4	6.5	23.1	8.4
Total	24	25	28	12.5	6.3	11.4	7.7

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: The ellipses indicate less than 1 percent.

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[5] Cassava is not included in roots and tubers.

of roots and tubers increased, although world trade in potatoes declined.[6] Of the 28 items included in miscellaneous fresh vegetables, the developing countries either maintained or increased their share of world trade in most of them during the period (Appendix 1, Table 42 and 43).

Among the processed vegetables, miscellaneous vegetables constituted 70 percent of total world trade, with pulses accounting for 25 percent and roots and tubers 5 percent during 1983-85. The developing countries consistently increased their share of world trade in the processed miscellaneous vegetables.

Changing Shares of Developing Countries in World Trade

Although developing countries achieved high rates of growth in exports of many products that were experiencing rapid growth in the world market, export growth in the developing countries was not necessarily correlated with growth in the world market. Among the fruits and vegetables with high rates of growth in world trade, developing countries gained in some and lost in others. For example, out of 11 vegetables with growth rates of 10 percent or more on the world market in 1975-85, developing countries lost in 4 and gained in 7. Similarly, out of 11 fruits that attained rates of growth of 10 percent or more on the world market, developing countries lost in 5 (Table 12).

A number of factors, bearing on both the export supply and the demand for individual commodities, affect the developing countries' share of world trade. An expanding world market expands the demand for exports and reduces the intensity of competition with other suppliers. But a country's prevailing market share is also important. The higher the existing share of world trade, the greater the difficulty in increasing it further. A high market share means that a country has already substantially exploited its comparative advantage, and it can only be further strengthened by improving quality or reducing cost. In an expanding market, there is upward pressure on prices; hence it is easier to achieve a rise in market share. Exploitation of the increased opportunity, however, depends on competitive production costs and marketing efficiency. In a shrinking market, there is downward pressure on the market price; an expanding share in a shrinking market can only be attained through substantial cost-reducing innovations.

Research and development directed to horticultural products in developing countries was limited and not well-organized—not at all comparable to the research efforts devoted to cereals or agricultural raw materials or tropical beverages. At the same time, however, technological progress in developed countries was considerable and strengthened in recent years by biotechnological research (Moulton et al. 1986). The comparative advantages of the developing countries resided, first, in lower wage costs in products for which mechanization was not cost-effective, and second, in their agroclimatic advantage in a few tropical and specialized horticultural products. High productivity resulting from technological progress in developed countries tended to offset the advantage of low labor costs in developing countries.

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[6] This was caused by a significant decline in aggregate demand and thus in import demand for potatoes in developed countries, especially in Western Europe, which is the dominant import market for potatoes, 20 times larger than that of the United States. The decline in demand for potatoes also caused production in Western Europe to decline (FAO 1985).

Table 12—Distribution of fruits and vegetables by change in developing countries' share of world trade, 1976-84, and by growth rates of world exports, 1975-85

	Annual Rate of Growth of World Trade			
Share Change, 1975-85	5 Percent or Less	6–9 Percent	10 Percent or More	Total Number of Commodities
	(number of commodities)			
Vegetables				
More than 100 percent	2	2	1	5
11–100 percent	5	6	5	16
0–10 percent	1	3	1	5
Less than 0 (cost share)	0	2	4	6
Total	8	13	11	32
Fruits				
More than 100 percent	2	2	3	7
11–100 percent	5	2	3	10
0–10 percent	3	3	0	6
Less than 0 (cost share)	6	6	5	17
Total	16	13	11	40

Source: Data on horticultural products compiled by the author from various FAO sources.

In many instances, in commodities that experienced a rapid expansion of demand in developed countries with a growing imbalance between domestic supply and demand, technology was transferred to the developing countries to initiate or increase production at competitive costs, frequently with the participation of multinational enterprises or contracts between farmers and importing enterprises. This happened in a few countries in the production and export of pineapples, tomatoes, apples, and grapes, for example, which will be explained further in Chapter 7. Obviously, the trade regime, including the degree of trade restriction in the importing countries, also affected changes in the market shares of developing countries.

Major Exporters of Horticultural Products

A large number of developing countries participate in varying degrees in world horticultural trade. For example, during 1983-85, about 123 developing countries exported horticultural products in varying amounts compared with 31 developed countries. While the number of developing countries exporting horticultural products was four times larger than the number of developed countries, each developing country had a much smaller share of the world market. Four exporting developed countries—but none of the developing countries—had more than a 5 percent share of the world market.

The concentration of exporters was similar in developed and developing countries. Twelve countries accounted for 65 percent of the total horticultural exports of developing countries, and 10 countries accounted for 81 percent of the horticultural exports of developed countries. During 1983-85, 31 countries accounted for 89 percent of the developing countries' total horticultural exports and 70 percent of their total agricultural exports. Over the years the share of these 31 countries in total agricultural exports and in horticultural exports rose, not only in developing-country trade, but also in the world as a whole. At the same time, their share of horticultural exports in total agricultural exports increased (Table 13).

Table 13—Top 31 developing-country horticultural exporters' share of horticultural and agricultural exports, 1961-85

Position	1961-63	1975-77	1983-85
		(percent)	
Share of world horticultural exports	24.47	29.21	32.76
Share of horticultural exports in total agricultural exports	11.77	13.84	16.52
Share of total horticultural exports of all developing countries	73.77	86.80	89.32
Share of agricultural exports of all developing countries	56.04	65.47	70.45

Sources: Food and Agriculture Organization of the United Nations (FAO), "Trade Yearbook Tape, 1985," FAO, Rome, 1986; and data on horticultural products compiled by the author from various FAO sources.

The leading 31 developing-country exporters also accounted for 97 percent of the aggregate increase in exports of all developing countries between 1970-72 and 1982-84. Because the increase in export earnings was predominantly enjoyed by a limited number of exporters, the tendency toward concentration of export markets was accentuated. Although the 31 exporters as a group increased their share of the world market, their individual export performances varied considerably. Did their relative positions in world trade change over time? How did the performance of the principal exporters of today evolve? How many have become exporters only in the past 10 years, and how many have been established exporters for many years?

The composition of the 12 leading exporters changed somewhat from 1961-63 to 1983-85: of the top 12 in 1983-85, 8 were in this group in 1961-63 and 10 in 1975-77. Seven countries—Argentina, Mexico, Morocco, People's Republic of China, the Philippines, Taiwan, and Turkey—retained their positions throughout the entire period. But 3 countries—Ecuador, Honduras, and Singapore—that were among the top 12 in 1961-63 were replaced by Brazil, Costa Rica, and Thailand by 1975-77. Egypt and India, which stayed in the top 12 until 1983-85, were replaced by Chile and Honduras during the final period.

These changes in the top 12 positions illustrate that there was vigorous competition among the developing countries in the export markets. Their relative competitive positions changed over time in response to changes in cost conditions, introduction of new crops, and improvements in transportation and other infrastructure for export marketing. Five countries that were among the top 12 in 1983—Brazil, Chile, People's Republic of China, the Philippines, and Turkey—had consistently rising export market shares. Five countries not included in the top 12 in 1983-85 that consistently increased their market shares between 1961-63 and 1983-85 were Colombia, Guatemala, Hong Kong, Jordan, and Kenya. The shares of the remaining 21 countries fluctuated.

When the period is divided into two decades, in 1965-75, 17 out of 31 countries had growth rates above the developing-country average (10.7 percent); they ranged from 10.7 percent to 45.4 percent (Appendix 1, Table 44). However, 10 of the 17—Afghanistan, Argentina, Costa Rica, Côte d'Ivoire, Cyprus, Egypt, Iran, Republic of Korea, Mexico, and the Philippines—suffered significant declines in the next decade. In 1975-85, 11 out of the 31 countries had annual rates of growth of exports higher than the developing-country average of 8.7 percent, ranging from 9.0 percent to 27.5 percent per year. Growth rates accelerated for all except Thailand and Turkey during 1975-85. The growth rates of exports of the 12 leading exporters were distributed as follows:

Country	Rate of Growth	Range
Brazil, Chile, Honduras, Thailand, and Turkey	More than 10	10-21
Costa Rica, Mexico, the People's Republic of China, the Philippines, and Taiwan	More than 5	5-9
Argentina and Morocco	More than 1	1-2

The average value of horticultural exports of the 12 countries in 1975-85 was $240 million. Eight countries not in the top 12 had growth rates around 8 percent during this period (Colombia, Cuba, Guatemala, Hong Kong, Kenya, Korea, Liberia, and Singapore), but they were not included in the leading 12 because the average annual value of their exports was only between US$77 million and US$190 million during 1983-85.

Concentration in Horticultural Trade: Sellers and Products

An examination of the markets for individual commodities reveals that four exporters (each exporting 5 percent or more of the total developing-country exports of that commodity) accounted for 80-100 percent of the total exports of developing countries in that commodity in 1983-85. The composition of the four countries varies from commodity to commodity, however. For 23 out of 30 vegetable exports and 27 out of 39 fruits (each worth US$50 million or more), the four top exporters accounted for 80 percent or more of total exports of that product, as indicated in Table 14. The concentration of horticultural exports in the hands of a few exporters was also true for developed countries, as shown in Table 15.

Tables 45 and 46 in Appendix 1 indicate those developing countries that were among the top four exporters for selected fruits and vegetables. For fruits, the dominance of the top four exporters is indicated by the following: Brazil and three other countries accounted for 87 percent of orange juice, shelled cashew nuts, and pineapple juice and 57 percent of miscellaneous fruit juices. Chile and three other countries accounted for 70-90 percent of grapes, apples, pears, miscellaneous nuts, and miscellaneous dried fruits. The Philippines and three others accounted for 80-100 percent of fresh and canned pineapples, desiccated coconuts, and pineapple juice (Appendix 1, Table 45). In vegetables, Taiwan and three other countries accounted for 70-100 percent of the total developing-country exports of the following commodities: prepared vegetables not elsewhere specified (n.e.s.); dehydrated, frozen, and temporarily preserved vegetables; fresh and dried mushrooms; and cabbages. Mexico and three other countries accounted for 80-90 percent of prepared vegetables n.e.s., tomatoes, tomato paste, and chickpeas. Turkey and three others accounted for 90-100 percent of tomatoes, chickpeas, lentils, tomato paste, and broad beans (Appendix 1, Table 46).

Why have a few exporters dominated trade, and what are the implications? One reason, of course, is agroecological characteristics; many horticultural products are

Table 14—Shares of four leading fruit and vegetable exporters in total developing-country exports, 1983-85

Horticultural Products	Number of Commodities in Group	Share
		(percent)
Fruits		
Apple juice (single strength), cherries, orange juice concentrate, dried prunes and plums, hazelnuts, prepared nuts, walnuts, shelled almonds, shelled cashew nuts, and desiccated coconuts	10	100
Peaches, nectarines, strawberries, avocados, shelled hazelnuts, and cashew nuts	6	95–99
Raisins and orange juice (single strength)	2	90–94
Grapes, pears, grapefruit, watermelons, plums, pineapple juice (single strength), apples, canned pineapples, and nuts n.e.s.	9	80–89
Tropical fresh fruit n.e.s., tangerines, cantaloupes, melons, and dried fruit n.e.s.	5	70–79
Bananas, oranges, lemons and limes, fresh fruit n.e.s., and dates	5	60–69
Fruit juice n.e.s, and fruit preparations n.e.s.	2	40–59
Vegetables		
Lentils, canned mushrooms, dried mushrooms, mushrooms, broad beans, asparagus, cabbages, cauliflower, lettuce, and canned vegetables n.e.s.	10	100
Chickpeas, flour of potatoes, cucumbers, tomato paste, and frozen vegetables	5	95–99
Carrots, vegetables temporarily preserved, tomatoes, dried peas, preserved olives, chilies, and peppers	6	90–94
Vegetables preserved by vinegar, prepared vegetables n.e.s.	2	80–89
Garlic, dehydrated vegetables, pulses, and dried beans	4	70–79
Potatoes and dried onions	2	60–69
Fresh vegetables n.e.s.	1	45–59

Source: Data on horticultural products compiled by the author from various FAO sources.
Notes: n.e.s. is "not elsewhere specified."

highly specific to certain soil and climatic characteristics. Only a few developing countries have a wide enough diversity of soil and climatic characteristics to produce a large variety of horticultural products. Second, horticultural exports require a high level of infrastructure in terms of marketing, storage, packaging, and shipping facilities. Therefore, the initial costs of entering export production are high, and the learning period is long. Also, horticultural products vary widely in taste, color, appearance, and quality; they are highly differentiated products. New grades and varieties cannot be easily established: it takes time for consumers to become accustomed to new products. Third,

Table 15—Shares of four leading fruit and vegetable exporters in total developed-country exports, 1983-85

Horticultural Products	Number of Commodities in Group	Share
		(percent)
Fruits		
Grapefruit juice (single strength) and tropical fruit	2	100
Grapefruit juice concentrate, dried plums, hazelnuts, chestnuts, almonds (shelled), and preserved olives	6	95–99
Bananas, tangerines and mandarins, grapefruit, peaches and nectarines, raisins, avocados, walnuts, pistachios, shelled hazelnuts, prepared nuts, and desiccated coconuts	11	90–94
Lemons and limes, cherries, strawberries, watermelons, cantaloupes, pineapples, canned pineapple, pineapple juice, and dates	9	80–89
Oranges, orange juice (single strength), apple juice (single strength), apple juice concentrate, grapes, and dried fruit n.e.s.	6	70–79
Pears, plums, and fresh fruit n.e.s.	3	60–69
Apples and fruit juice n.e.s.	2	50–59
Vegetables		
Chickpeas	1	100
Frozen potatoes and dried mushrooms	2	95–99
Asparagus, peeled tomatoes, cauliflower, pumpkins, canned mushrooms, and canned vegetables n.e.s.	6	90–94
Flour of potatoes, dried beans, lentils, tomatoes, tomato paste, cucumber, chilies and peppers, and garlic	8	80–89
Pulses, lettuce, dried onions, carrots, and mushrooms	5	70–79
Potatoes, dried beans, fresh vegetables n.e.s., dehydrated vegetables, and vegetables temporarily preserved	5	60–69
Prepared vegetables n.e.s. and frozen vegetables	2	50–59

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: n.e.s. is "not elsewhere specified."

new entrants into the market have to adjust their product characteristics and qualities to meet the sanitary and health regulations of the importing countries; the established exporters have a built-in advantage. Finally, exporters usually specialize in different markets, adjusting their products to the preferences of consumers in one or two markets. To overcome consumers' preferences for the products of established exporters in selected markets takes both time and promotional effort. Specialization by exporters in markets is often governed by transportation costs and hence by geography. Also, the market for each individual horticultural product is rather small. The size of the export market relative to the output in many cases is not large enough to allow many exporters to succeed. An increase in the number of exporters is likely to result in a decline in price, which could force out all but the most efficient or low-cost producers. This is why the share of the market in a particular commodity that is held by the four largest exporters is related to the size of the overall market. The larger the export market, the lower the degree of concentration and the smaller the share of the market held by the four leading exporters.

Major Markets for Horticultural Exports

Where are the major markets for horticultural exports? The developed countries, including centrally planned economies, accounted for 83 percent of world imports during 1983-85; the developing countries accounted for 17 percent.

The rate of growth of imports of horticultural products in the second decade (1975-85) exceeded that of total agricultural imports, starting from almost equal or lower rates of growth during the first decade (1965-75). This was true for both developed and developing countries. In addition, the annual rates of growth of horticultural imports during both periods were higher for developing countries than for developed countries, even though the developed countries continued to import much more.

	Developed-Country Imports		Developing-Country Imports	
Period	Total Agriculture	Horticulture	Total Agriculture	Horticulture
		(percent)		
1965-75	11.30	11.01	13.40	12.60
1975-85	4.75	6.30	8.67	9.30

This is reflected in the rising share of developing countries in world horticultural imports, which rose from 12 percent in 1961-63 to 14 percent in 1975-77 and to 17 percent in 1983-85. The fastest growing regional markets in the developing world were in Far East and Near East, while Latin America's share declined. In the developed world, the markets of North America and Japan grew; both had rising shares of the world's imports, but they were more than offset by the declining shares of other developed regions, especially of Western Europe. Western Europe remained the biggest market in the world for horticultural products, accounting for 50 percent of world horticultural imports during 1983-85, even though its relative share declined over time.[7] Western Europe imported three times as much as North America during 1983-85. North America's share of world imports increased from 12 percent to 18 percent between 1975-77 and 1983-85. The annual rates of growth of horticultural imports of principal developed markets are as follows:

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[7] Trade between countries in Western Europe are included in Western European imports, and trade between the United States and Canada is included in North American imports. If intraregional trade were excluded, the relative size of the import market of Western Europe would be less than what is indicated. Western European imports, including intraregional imports, were almost 300 percent higher than those of the United States, but if intraregional imports were excluded, they would be 80 percent higher than the imports of the United States.

Period	United States	Western Europe	Japan
		(percent)	
1965-75	8.38	11.00	18.25
1975-85	15.03	4.82	10.63

Japan had the highest growth rate of imports in 1965-75, but it slowed considerably during the next decade, along with that of Western Europe, whereas the U.S. growth rate increased during the second decade.

What were the major sources of imports of the developed market economies? In general, intraregional trade was more important than extraregional trade. The largest single source of imports of each region was the region itself or a neighboring region. This was less true for developing countries than for developed countries, partly because major sources of imports, as well as exports, were in the developed countries. During the early 1980s developed countries obtained 72 percent of their imports from other developed countries: Western Europe provided 55 percent and North America 12 percent (Figure 1). The developing countries provided 28 percent of imports, with Latin America accounting for 13 percent.

The most important sources of imports of each region during the early 1980s were as follows: Western Europe, 70 percent from Western Europe; North America, 42 percent from Latin America and 29 percent from North America; Eastern Europe, 49 percent from Western Europe and 32 percent from the Near East; Latin America, 59 percent from Latin America and 35 percent from North America; Near East, 42 percent from the Near East and 29 percent from Western Europe; Africa, 60 percent from Western Europe, 11 percent from Africa, and 11 percent from the Near East; Far East, 30 percent from North America and 24 percent from the Far East.

Between the early 1970s and early 1980s, the share of developing countries in the imports of developed countries increased from 26 to 28 percent, a relatively modest increase. Nevertheless the developing countries depended heavily on the developed countries as a market for their exports: 79 percent of developing-country exports went to developed countries during 1982-84, declining from 84 percent in 1970-72 (Figure 2). Even though intradeveloping-country trade increased from 16 percent in 1970-72 to 21 percent in 1982-84, the developed countries still dominated the market. Also, developed countries remained a major source of imports of developing countries—49 percent during 1982-84 compared with 45 percent during 1970-72.[8] The dependence of the developing countries on the developed countries as a market for their exports was much greater than their dependence on them as a source of imports.

Since most exports from both developed and developing countries were destined for the developed countries, the neighboring developed region was the largest export market for all regions except the Far East; its exports were more widely distributed. The most important export markets for each region were as follows: Western Europe, 87 percent to Western Europe, 3 percent to Eastern Europe, and 2 percent to the Near East; North America, 34 percent to North America, 27 percent to Western Europe, and 7 percent to the Far East; Africa, 78 percent to Western Europe and 7 percent to

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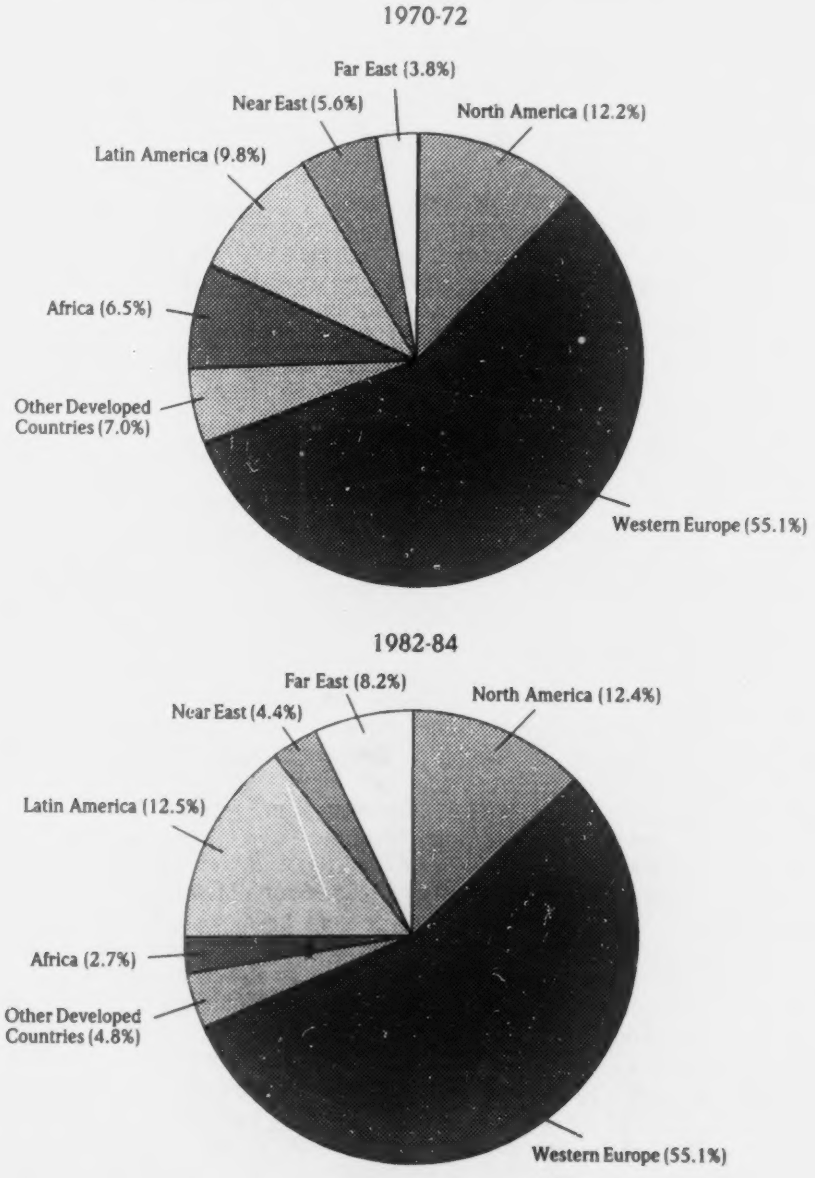
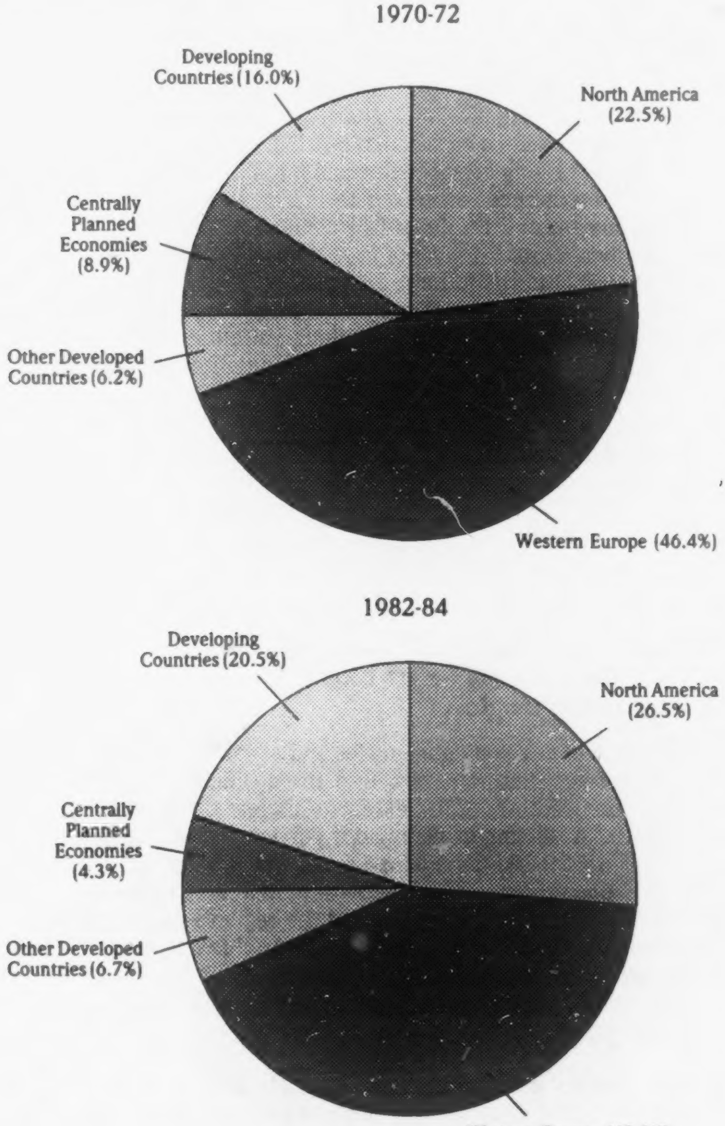
[8] The source of data for the direction of trade flows is the United Nations' trade matrix data tape (United Nations, various issues).

Figure 1—Regional shares of developed-country imports, 1970-72 and 1982-84



Source: United Nations, "Trade Data Tape," New York, 1987.

Figure 2—Destinations of exports of developing countries, 1970-72 and 1982-84



Source: United Nations, "Trade Data Tape," New York, 1987.

Africa; Latin America, 51 percent to North America and 12 percent to Latin America; Near East, 40 percent to Western Europe and 26 percent to the Near East; Far East, 58 percent to Western Europe, 18 percent to other developed countries, and 9 percent to the Far East.

Geographical proximity plays an important role in trade of horticultural products, first, because many fruits and vegetables are highly perishable, and the costs of packaging and processing them for long-distance transport are high. Second, tastes for horticultural products tend to be similar in neighboring regions, partly because products grown under the same conditions are likely to be familiar. Finally, trade tends to flow between countries and regions that have long-established economic relationships. For example, in Western Europe, trade preferences are given to European Community countries, but also to African, Caribbean, and Pacific (ACP) countries that have historical ties (Alvensleben 1982). In any attempt to promote horticultural exports in the future, the special role of regional markets needs to be recognized.

That export markets tend to be concentrated by region is true not only when the exports of different regions are considered as a whole but also for individual exporting countries. The following table shows the market specialization of principal exporters in 1982-84.

Percentage of Exports Destined for One Region	Number of Countries
70 or more	10
50–70	7
25–50	5

Constant Market Share Analysis of Exports of Different Developing Regions

The export performance of developing countries and of each region can be decomposed, on the basis of market share analysis, into three different components: *the import growth effect,* which represents the extent of increase in exports due to the overall growth of imports in all importing regions, under the assumption that the exporting region's share in all markets remains unchanged; *the market effect,* which represents a change in exports due to uneven growth of demand in importing regions (a positive market effect indicates a concentration of the region's exports in relatively fast-growing import markets); and *the competitive effect,* which represents a change in the region's competitiveness and hence in its share of world markets. The model of the constant market share analysis is described in Appendix 2.

Africa

Among developing regions only Africa experienced a large decline in exports. Between 1970-72 and 1983-85 the real value of horticultural exports fell approximately 3 percent per year, mainly due to a decline in exports from Morocco and Algeria. Morocco, the largest horticultural exporter, accounted for 46 percent of the total exports of this region in 1983-85. However, some African countries—Kenya, for example—increased the real value of their exports.

The import growth effect for Africa was positive. That is, the actual increase in exports would have been positive if it had maintained its 1970-72 overall market share. The market effect, however, was negative, which indicates that Africa's exports were directed to the slower-growing import markets. The largest proportion of African exports went to Europe (including Eastern Europe), where import growth was below average, while Africa's market share of the fast-growing markets, such as North America and Japan, was very low—less than 1.0 percent of the North American market and 1.5 percent of the Japanese. The competitive effect was not only negative but so large that it offset the positive import growth effect. The negative competitive effect resulted in a loss in Africa's share of all markets. A recent IFPRI study shows that Africa was not able to improve or even maintain its competitive position in 37 out of 49 agricultural export commodities (Koester, Schafer, and Valdés 1988). The sources of growth in exports vary among different commodities. Africa lost competitive position in all categories of horticultural products except dried fruits. At the same time, the market effect was negative or zero in all cases except fresh fruits. The overall growth effect, in relation to the other two components, was most important for fresh fruits and processed vegetables and accounted for an increase in exports of those products.

Latin America

The horticultural exports of Latin America increased in real terms by approximately 4.9 percent per year during this period. Brazil, Chile, Colombia, and Cuba achieved the largest increases in exports.

Fifty percent of the increase in Latin American exports can be attributed to import growth. Also, the region sent its exports to markets with relatively fast-growing import demand—North America and Japan. During 1970-72 Latin America's share of North American imports was approximately 34 percent, and 22 percent of Japanese imports. Furthermore, the region gained in overall competitiveness and increased its share in all markets except Japan's.

Latin America suffered a decline in the real value of fresh vegetable exports because it lost market share, a loss that more than offset the positive overall growth effect, and also, though less important, some of the positive market effect. There was an increase in all other categories of exports. Along with positive growth and market effects, Latin America had a competitive advantage in processed fruits and vegetables. For example, 50-60 percent of the increase in these two categories of exports was due to a rise in market share. In the case of fresh and dried fruits, Latin America suffered a negative competitive effect, which was more than offset, however, by the positive overall growth and market effects.

Near East

The Near East increased its export earnings by an amount that accounted for 22 percent of the total increase in exports of all developing countries. Although the market and the competitive effects were both positive, it was the positive import growth effect that explained an overwhelming proportion of the increase in earnings during this period. The region did diversify its export market somewhat, mostly by boosting intraregional trade. The proportion of intraregional exports increased from 5.7 to 25.6 percent between 1970-72 and 1983-85. The importance of the Eastern European market decreased from 27.3 to 13.7 percent.

All major exporters in the region, except Iran, increased their exports. Turkey, the biggest exporter, was responsible for 63 percent of the region's increase in exports.

In both fresh and dried fruits, the Near East suffered from significant negative competitive effects that more than offset the positive growth and market effects. A positive competitive effect largely accounted for the increase in exports of processed fruits and vegetables; the next most important factor was the positive import growth effect. In the case of fresh vegetables, positive competitive and market effects were primarily responsible for the increase in exports.

Far East

The export markets of the Far East were more widely diversified than those of the other regions. The region exploited its comparative advantage by expanding its share of the world market. Unlike other developing regions the competitive effect was most significant in the Far East, followed by positive import growth and market effects in that order.

Among Far Eastern countries, all the major exporters achieved significant increases in exports. No country experienced a decline in its export earnings. The region gained competitive advantage in all categories of exports except processed fruits and vegetables. Increases in processed vegetables were due to positive growth and market effects that more than offset the negative competitive effects. A positive competitive effect was the most dominating factor in the export growth of fresh fruits, dried fruits, and fresh vegetables. In the case of fresh and processed fruits, the market effect was quite important. Only in fresh vegetables was the market effect negative and offset by positive competitive and growth effects in that order.

Conclusions

In summary, among the different factors contributing to growth in export earnings in various regions, the overall growth effect was the most important factor in the Near East, accounting for 74 percent of the region's exports, and the competitive effect—change in market share—was the most important factor in the Far East, accounting for 43 percent of the increase in its exports (Table 16). For Latin America, the overall growth effect and the market effect, in that order, were the important factors. In terms of market effect, Latin America gained more than any other region from concentration of its exports in the fast-growing markets. Whereas both Latin America and the Near East increased their market shares, their success in this respect was much less pro-

Table 16—Distribution of total change in exports due to various components of constant market share analysis by region, 1970-72 and 1983-85

Region	Change in Exports	Growth Effect	Market Effect	Competitive Effect
			(percent)	
Africa	−100	175.9	−23.8	−252.2
Latin America	100	50.5	33.5	16.0
Near East	100	74.1	7.8	18.1
Far East	100	37.3	20.1	42.6
All developing countries	100	72.3	23.8	3.9
All developed countries	100	120.4	−15.4	−5.0

Sources: Data on horticultural products compiled by the author from various FAO sources; and United Nations, "Trade Data Tape," New York, 1987.

nounced than that of the Far East. Africa lost heavily in market share because it exported to markets that were growing slowly.

Developing Countries as a Whole

About 72 percent of the increase in the real value of exports of developing countries as a whole was explained by the overall growth in imports. Positive market effects were next in importance, accounting for 24 percent of the total increase in exports. Although there was a gain in market share for developing countries, its importance was relatively small. Only 4 percent of the increase was accounted for by a positive competitive effect. Because the developed countries increased the share of imports in their aggregate consumption of horticultural products, the developing countries were able to reap the benefits of overall growth and also to capture a larger share of this market.

Developed Countries as a Whole

The exports of developed countries suffered from both negative market and competitive effects. They not only lost market share but their exports were not predominantly directed to fast-growing markets. However, overall exports did increase due to the high growth of aggregate world import demand.

Among developed countries, five big exporters—the United States, the Netherlands, Spain, France, and Italy—whose combined market share in the world market was almost 40 percent, accounted for 73 percent of the total increase in exports of developed countries. North America and Western Europe increased their market shares slightly, but other developed regions such as Oceania, Japan, and Eastern Europe lost market shares.

4

DETERMINANTS OF EXPORT PERFORMANCE: A QUANTITATIVE ASSESSMENT

As earlier chapters have shown, developing countries differed widely in their export performance in horticultural products, not only in the volume or value of exports but also in the relative importance of horticultural exports in their total agricultural exports, as well as their relative share in world horticultural exports. Furthermore, both the rate of growth of horticultural exports and market shares changed over time. Obviously, differences in export performance depended on both supply and demand conditions, that is, on factors influencing the production and exportable surplus of horticultural products in the exporting countries, on the one hand, and the circumstances governing demand in the importing countries, on the other.

In this chapter, the factors that may have contributed to the differences in performance of exporting countries are analyzed, and price and income elasticities of demand and supply of exports are estimated. The latter is expected to check the realism and consistency of assumptions made in later chapters, especially those regarding the price elasticities of export supply and demand.

In this context, a few general characteristics of the 31 principal exporting countries that accounted for 90 percent of the horticultural exports of developing countries should be noted. First, the overwhelming majority of the exporting countries belong to the middle-income category.[9] This was so in 1983-85, the last period for which the published export data are analyzed, but it was also true as early as 1975. Four of the 31 countries were in the low-income category, whereas 8 countries were in the upper middle-income category and the rest in the lower middle-income category.

Second, many of the principal horticultural exporting countries also did well in manufactured exports. The export of horticultural products requires a certain level of skill and sophistication in postharvest operations, including grading, packaging, storing, transporting, and shipping abroad. This is because of the perishable nature of products and the risk of deterioration in quality in the course of handling, storing, and transporting if these operations are not done carefully and according to a rigid time schedule. Moreover, their production requires not only careful husbandry but also more sophisticated management than other agricultural products.

The processing of horticultural products requires a degree of organization and management that is often associated with a high level of income and a developed domestic market. The actual techniques of processing of horticultural products may not require a high level of technology, but quality control, compliance with strict health and sanitary standards, and efficient packaging are important for export marketing. The sophistication and organizational requirements for horticultural exports, especially processed exports, resemble those for manufacturing exports.

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[9] The income categories are defined in the World Bank's *World Development Reports* (various years).

Factors Contributing to Differential Export Performance

The following factors are important in determining the differences between the export performance of countries with the same general external economic environment. Per capita income, as an explanatory variable (GDP), is a combination of many factors. First, it represents the size and attractiveness of the domestic market because it determines the relative pull of domestic demand. High per capita income implies a larger domestic market and enables the realization of economies of scale in marketing and processing, which provides a cost advantage in the export market. Experience in selling in a large national market facilitates export marketing. Potential exporters "learn by doing" in packaging, processing, and selling in the national market, especially the urban market. Second, a national market provides a cushion to absorb the shocks from fluctuations in demand in the export market. Per capita income is also partly a surrogate variable for the availability of infrastructure such as transportation, communication, and credit for both production and export.

Social and physical infrastructure variables, such as the level of education in the country (literacy or enrollment in primary and secondary schools, for example), the number of vehicles per square kilometer, the number of tons carried by rail per square kilometer, and the number of tons loaded onto ships in the harbors, are considered relevant in explaining horticultural exports. However, the data on these variables necessary to undertake a systematic analysis is often either not available or of very poor quality. Proxies are used to represent some of these variables. For instance, availability of shipping facilities as indicated by the tonnage loaded in the ports of respective exporting countries (LOAD) is a proxy for physical infrastructure, and secondary school enrollment (EDU) is a proxy for skilled labor or human infrastructure. These proxies are not very satisfactory. Therefore, in many cases, per capita income (GDP) is assumed to represent the level of human infrastructure, including training and education and physical transport and communication facilities, both internal and external.

The real exchange rate variable (RER)[10] represents the effect of macroeconomic policy on the international competitiveness of the exporting countries. This variable is constructed so that an increase in the real exchange rate indexes indicates an appreciation. Therefore, a rise in the real exchange rate should lead to a decrease in exports and vice versa.

The supply of exports is naturally expected to depend on domestic production (PROD). Unless horticultural products are exclusively produced for and sold in domestic markets, a high level of production will result in an increase in export supply.

As indicated before, the processing of horticultural products often requires the same level of organizational and management skills associated with manufacturing exports. Therefore, countries that do well in manufacturing exports are expected to have a competitive advantage in horticultural exports. Hence, the share of manufactured exports in total exports (SMAN) is designated an explanatory variable.

An attempt is also made to identify a variable to indicate the relative openness or outward orientation of an economy. It is assumed that a relatively open economy is likely to have a higher ratio of trade to GNP than others. However, the size of the economy is important; a large economy is likely to have a lower trade-GNP ratio than a smaller economy, given the same degree of discrimination against the tradable sector. In the sample of countries considered in the econometric analysis, variations in sizes of economies are not significant. An index of trade dependence (TDEP)—the ratio of exports and imports (total trade) to GNP—is used as an index of openness of the economy. Basic data sources for each of these variables are provided in Appendix 2.

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[10] To calculate the real exchange rate, the nominal exchange rate of each country is adjusted by the differences between its own inflation rate and the weighted average inflation rate of the industrial countries, measuring inflation by the rate of increase of the implicit GNP deflator.

Tables 17 and 18 indicate the degree of general association between export performance and a few of the foregoing factors. In Table 17, for example, countries are grouped according to their exports per capita. The corresponding values of other variables for each group show that a higher level of exports per capita is associated with higher domestic production per capita, income per capita, relative openness of the economy, and shipping facilities. However, there is no clear association between the value of exports per capita and either the educational level or the share of manufactured commodities in total exports. In Table 18 the rates of growth of the various factors all seem to be related to the rate of growth of exports; that is, a higher growth rate of exports is associated with higher rates of growth in other variables. The criteria for grouping the countries are the value of exports per capita during 1982-84 in Table 17 and the rate of growth of export values during 1975-84 in Table 18.

An attempt is made to quantify the relative importance of the factors that explain the differences in performance of various countries. The export performance equation below is not a reduced-form equation derived from a full structural model, and therefore, it is not related to the structural equations in the next section.

The modest aim of this equation is to explore whether there is any association between the horticultural exports of various countries and characteristics of their economies that seem relevant in light of the analysis in previous chapters and earlier studies on the subject. Hence, a simple regression model is attempted.[11] In this exercise no attempt is made to interpret the estimated coefficients as estimates of elasticities of export volumes with respect to various explanatory variables. In fact, the focus of attention is *not* on the *magnitude* of these coefficients but on their significance. In

Table 17—Absolute level of each variable, by country group, 1982-84

Variable	Group 1	Group 2
Exports per capita (US$)	31.67	6.49
Production per capita (kilograms)	0.32	0.17
GDP per capita (1980 US$)	1,848	1,199
TDEP	0.75	0.33
LOAD per capita (kilograms)	1.07	0.41
EDU	0.47	0.46
SMAN	0.23	0.35

Sources: See Appendix 1 for sources of basic data for each variable.
Note: Group 1 represents countries with per capita exports above the sample average, and Group 2 is countries below the average. TDEP is the variable for trade dependence, LOAD is tonnage loaded in exporting countries, EDU is secondary school enrollment, and SMAN is the share of manufactured exports in total exports.

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[11] Such a model is neither an export demand nor an export supply function, nor is it derived from a comprehensive structural model of the sector. Such models, called export performance or export determination models, abound in the conventional international trade literature. See Diakosavvas and Kirkpatrick (1989) for references.

Table 18—Average annual growth rates, by country group, 1975-84

Variable	Group 1	Group 2
	(percent)	
Export	15.21	4.14
PROD	2.80	2.07
GDP	2.51	1.59
TDEP	0.55	−0.13
LOAD	6.12	2.09
EDU	0.91	0.76
SMAN	2.67	0.65

Sources: See Appendix 2 for sources of basic data for each variable.

Notes: Group 1 represents countries with growth rates of exports above the sample average, and Group 2 is countries below the average. PROD is domestic production, GDP is income per capita, TDEP is trade dependence, LOAD is tonnage loaded in exporting countries, EDU is secondary school enrollment, and SMAN is share of manufactured exports in total exports.

other words, the idea is to explore whether there is a significant association between these variables and exports.

Since the rationale for including explanatory variables in the equation is based on general considerations, the specification of the equation may not be complete, and exclusion of some important variables may bias the estimated coefficients. One hopes that the results of this exercise can be used as a starting point in selecting a set of exogenous variables to be included in a more general structural model.

With that end in view, an econometric exercise is carried out by pooling the cross-section and time series data for 25 countries over the period 1975-84. The variables are expressed as logarithms of index numbers. The regressions explaining export performance are estimated using the dummy variable model.[12] The form of the estimated equation is as follows and the results are given in Table 19.

$$\ln X_{ti} = a_i + b\ln(RER)_{ti} + c\ln(GDP)_{ti} + d\ln(PROD)_{ti} + e\ln(TEP)_{ti} + f\ln(LOAD)_{ti} + g\ln(EDU)_{ti} + h\ln(SMAN)_{ti} + u_{ti}; \quad (1)$$

$t = 1975, \ldots 1984; \; i = 1, \ldots 25.$

In the first regression in Table 19 two sets of variables are used to explain export performance—two domestic factors, GDP and PROD, and two external factors, RER and TDEP. As expected, the estimated elasticity of domestic production is significant.[13]

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[12] In this model an intercept dummy corresponds to each country. The dummy variable that corresponds to country i takes the value one for observations for country i but zero for observations on the other countries.

[13] The question may be raised of whether domestic production of horticultural commodities can be treated as exogenous. Since exports of horticultural products constitute less than 3-4 percent of total horticultural products, the possibility of any simultaneity problem between exports and domestic production is minimal. Even the export market for products such as bananas, if taken for developing countries as a whole, constitutes a relatively small percentage of their total domestic production.

Table 19—Estimates of export performance, 1975-84

Regression Number	Elasticity of Quantity with Respect to							
	RER	GDP	PROD	TDEP	LOAD	EDU	SMAN	$\bar{R}^2$
1	0.072 (0.571)	0.492* (3.002)	0.966* (7.298)	0.065 (0.726)	...	...	...	0.34
2	...	...	0.902* (6.867)	0.074 (0.101)	0.206* (4.386)	0.162* (2.000)	...	0.38
3	...	...	...	0.031 (0.372)	0.256* (4.954)	0.351* (4.205)	0.108* (1.950)	0.24
4	...	0.521* (3.449)	0.914* (6.950)	...	...	...	0.110* (2.186)	0.36
5	...	0.575* (3.494)	...	...	0.209* (4.037)	0.248* (2.878)	0.116* (2.169)	0.36

Sources: See Appendix 2 for sources of basic data for each variable.

Notes: PROD is domestic production, GDP is income per capita, TDEP is trade dependence, LOAD is tonnage loaded in exporting countries, EDU is secondary school enrollment, and SMAN is share of manufactured exports in total exports.

* = Significant at the 95 percent level.

GDP used as a surrogate variable also turns out to be very significant. GDP includes, among other factors, the effect of export-related infrastructure of the economy. However, neither RER nor TDEP appear to have any significant explanatory power.

In the second regression, GDP is replaced and two variables relating to infrastructure, LOAD and EDU, are introduced. Both of these variables prove to be significant in explaining differences in export performance. Because GDP is also a surrogate for a multiplicity of factors, including the size of the domestic market, its implications for export, and the availability of infrastructure, it is combined in estimation with other variables such as PROD, LOAD, EDU, and SMAN. In all regressions containing GDP, the estimated elasticity of GDP is large and significant. SMAN turns out to have a significantly positive effect on exports.

Primary education and the degree of concentration in the composition of exports are also tried as explanatory variables, but they are not significant. Similarly, the commodity composition of exports—the proportion of fruits and vegetables in total horticultural exports—has no significant effect on export performance.

To the extent that horticultural products are labor intensive, countries with abundant labor in relation to land and with relatively low wages are likely to perform better in horticultural exports than those with scarce labor supply and relatively high wages. Data on relative wages in different countries are difficult to come by. The proportion of agricultural population per hectare of arable land may be considered a surrogate for the pressure of population on land. But a preliminary analysis does not indicate that this variable is related to horticultural exports, either in terms of the absolute or per capita quantity of exports or the market share, that is, the share of individual countries in world trade of horticultural products or the share of horticultural exports in total agricultural exports.

The finding that infrastructure, size of the domestic market, and shipping facilities are important factors influencing export performance seems to be consistent with expectations. The relevance of per capita income as a surrogate variable does not imply that low-income countries would not be able to make headway in the promotion of horticultural exports; it merely indicates the importance of the various factors that are represented by it. As a country develops its export-related infrastructure and as the domestic market expands, its export possibilities are more likely to be realized. These factors reflect or affect the general state of economic development, so that the capacity to export and compete in the world market grows at about the same pace as the increase in income.

This analysis confirms the importance of macroeconomic policies relating to public investment in infrastructure; public policies that encourage private investment also have an important role to play. Macroeconomic policies that relate to the export orientation of an economy and to exchange rate policy are not found to be significant factors. That exchange rate policy is not found to be significant does not necessarily imply that price elasticities of demand and supply of exports are not significant, however. This leads to the investigation in the next section, which explores the relationship of export prices to world prices, and whether domestic prices of exporting countries are important in explaining their export performance.

Export Demand and Supply Elasticities

In this section, export demand and supply equations are estimated for the horticultural exports of all the developing countries taken together, on the basis of historical time series data (see Appendix 2 for a more detailed description). The price and income elasticities obtained from this exercise indicate whether horticultural products enjoy a competitive advantage in terms of higher price and income elasticities (market opportunities), and they can also be used for projections and simulations.

This exercise is based on an imperfect substitution model, that is, neither imports nor exports are perfect substitutes for domestic goods. The justification for such a model has been argued extensively in the literature on the estimation of income and price elasticities relating to supply and demand of internationally traded commodities in the aggregate and for individual groups of agricultural commodities.[14]

Export demand is considered to be a function of the export prices of exporting countries, the prices of competing exporters, and the incomes of the importing countries. The demand equation is specified as follows:[15]

$$\ln X_t^d = a_0 + a_1 \ln(PX_t/PW_t) + a_2 \ln(YW_t), \tag{2}$$

where

X^d = the quantity of exports from developing countries,
PX = the export price of developing countries in dollars,
PW = the average export price in international markets, and
YW = the real income in importing countries.

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[14] Although a full structural general equilibrium model incorporating both the domestic and external markets for horticultural commodities might have been an ideal framework of analysis, such an exercise would require data of a kind not currently available, and not strictly needed to obtain a general idea of the sizes of elasticities involved in testing the realism and consistency of the elasticity coefficients used in subsequent simulation exercises. The imperfect substitution model used in a large number of studies to estimate price and income elasticities in international trade for disaggregated agricultural commodity groups, including foods, beverages, and raw materials, and for individual commodities is illustrated in Goldstein and Kann 1985, Bond 1987, and Stern, Francis, and Schumacher 1976.

[15] A similar set of demand and supply equations is used by Goldstein and Khan (1978) and Bond (1987) in obtaining export supply and demand elasticities.

Export supply in the exporting country is affected by current and lagged export prices, the domestic price level in producing countries, domestic production capacity, and supply shocks. The supply equation is specified as follows:

$$\ln X_t^s = b_0 + b_1 \ln(PX\,ER/P)_t + b_2 \ln(PX\,ER/P)_{t-1} + b_3 \ln(Y)_t + b_4(SS)_t, \qquad (3)$$

where

X^s = the quantity of exports from developing countries,

ER = the exchange rate of developing countries, in local currency per U.S. dollar,

P = the domestic price level in developing countries in local currency,[16]

Y = overall production capacity in developing countries, and

SS = supply shocks.

The domestic price relative to the export price is used to indicate the attractiveness of domestic versus foreign markets, and t−1 indicates the lag in the response of exports to price changes. The domestic production capacity variable is used as an explanatory variable since exporters' ability and willingness to supply exports are dependent on the production capacity of the economy as a whole. In other words, exports are expected to rise when there is an increase in the country's capacity to produce. Real income (GDP) is used as a surrogate variable of domestic production capacity. Apart from this, as mentioned earlier, GDP serves, first, as a surrogate variable for human and physical infrastructure, including training and education and transportation and communications and, second, as a variable for the size of the domestic market, which provides economies of scale in production and hence cost advantages in exports. The supply shocks are introduced to represent the two oil crises, one in 1974/75 and another in 1979/80, which dislocated the flow of world trade; hence dummy variables are used to indicate their effects.

The supply equation can be normalized for the price of exports as follows:

$$\ln(PX)_t = \beta_0 + \beta_1 \ln(X^s)_t + \beta_2 \ln(ER/P)_t + \beta_3 \ln(PX\,ER/P)_{t-1} + \beta_4 \ln(Y)_t + \beta_5 SS_t. \qquad (4)$$

The coefficients of the normalized equation are related to the structural parameters in the following way:

$$\beta_0 = -b_0/b_1,\ \beta_1 = 1/b_1,\ \beta_2 = -b_1/b_1,\ \beta_3 = -b_2/b_1, \text{ and } \beta_4 = -b_3/b_1,\ \beta_5 = -b_4/b_1. \qquad (5)$$

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[16] In constructing the series ER/P for the developing world as a whole, data from 31 countries, explaining 90 percent of total developing-country exports, were used: $ER/P = d\,\Sigma\alpha_i ER_i/P_i$, $\Sigma\alpha_i = 1$, where α_i is the weight of each country's GDP in the aggregate GDP of the top 25 developing exporters. This is the weighted sum of real exchange rates of each country; weights being the ratio of each country's GDP to the combined GDP of 25 countries. (Data from 25 countries instead of 31 are used because of data availability.)

In equilibrium, the following relationship holds, $\ln(X_t) = \ln(X^d)_t = \ln(X^s)_t$.

In this simultaneous equation model of export demand and supply, there are two endogenous variables, $\ln(X)_t$ and $\ln(PX)_t$, and six exogenous variables, including a predetermined (lagged) variable. They are $\ln(YW)_t$, $\ln(PW)_t$, $\ln(ER/P)_t$, $\ln(Y)_t$, $(SS)_t$, and $\ln(PX\ ER/P)_{t-1}$.[17]

Equations (2) and (4) are estimated simultaneously using a two-stage least squares (2SLS) technique for the period 1965-85. The estimated price and income elasticities of export demand and supply are reported in Table 20 for groups of fruits and vegetables.

The results show that the model used performs reasonably well in providing elasticity estimates that are statistically significant and of the expected sign. Estimates of price elasticities obtained in this section are, in general, comparable with the assumed price elasticities ranging between 0.5 and 1.0 that are used in the simulation of trade liberalization in Chapter 5.

The estimated price elasticities in the export demand equation are both negative and significantly different from zero at the 90 percent level in 13 of the 22 equations estimated. The following conclusions can be drawn from the estimation results of the demand equations.

1. The response of demand for exports to changes in relative prices differs widely among commodity groups. Total vegetables are higher than total fruits, and the elasticity tends to be higher for processed products than for fresh products for both fruits and vegetables. In every case, however, the estimated price elasticities in Table 20 are larger than those of other agricultural commodities obtained from past studies. The higher, though often inelastic, elasticities of horticultural products, ranging from −0.33 for fresh roots and tubers to −5.35 for nontropical juices, suggest that export earnings could be higher for horticultural products than for other agricultural commodities. Higher elasticities result from an increase in demand associated with a decline in price either when trade is liberalized in developed countries or when cost-reducing technological progress is made in developing countries. Past studies have indicated a range of average price elasticities for the groups of agricultural commodities between −0.42 for food products and −0.45 for beverages and tobacco.[18] Recent studies by Bond (1987) and Goldstein and Kahn (1985) also confirm relatively low price elasticities of export demand for agricultural commodities. Bond's range between −0.22 for food and −0.62 for agricultural raw materials, and Goldstein and Kahn's, between −0.58 for food and −0.67 for agricultural raw materials.

2. Most of the estimated income elasticities have the right sign and are significantly different from zero. The aggregate income elasticity is 1.16 for vegetables and 0.95 for fruits—considerably larger than for other agricultural commodities where the estimates usually fall in the range of 0.35 for beverages and tobacco to 0.80 for agricultural raw materials.[19] At more than 1.70 for both fruits and vegetables, the results demonstrate the elastic nature of export demand in response to income changes in processed horticultural products. Income elasticity is more than twice as large in processed

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[17] However, both equation (2) and equation (3) have homogeneous linear restrictions on the coefficients of some variables, for instance, between $\ln(PX)_t$ and $\ln(PW)_t$ in equation (2) and between $\ln(PX)_t$ and $\ln(ER/P)_t$ in equation (3).

[18] Studies by Behrman (1977) and UNCTAD (1974) calculated median demand elasticities from estimates gathered from about 200 studies, and Askari and Cummings' (1977) survey is a useful source for the supply elasticities.

[19] These figures are obtained as averages of individual commodities for the groups of commodities in Behrman (1977), UNCTAD (1974), and Askari and Cummings (1977).

Table 20—Demand and supply elasticities for fruit and vegetable exports using two-stage least squares, 1965-85

Commodity Group	Demand			Supply	
	Price	Income	$\bar{R}^2$	Price	$\bar{R}^2$
Fruits					
Fresh	−0.71*	0.74*	0.96	1.08*	0.98
Bananas	−1.60	0.67*	0.84	0.53*	0.99
Oranges	−0.60**	0.96*	0.96	1.42*	0.97
Tropical	−1.04**	0.38*	0.84	0.48*	0.96
Nontropical	−0.85	1.32*	0.93	0.56*	0.97
Treenuts	−0.78	0.17	0.06	0.18	0.92
Processed	−0.98	1.78*	0.98	1.29*	0.96
Nontropical juices	−5.35*	6.97*	0.96	3.58*	0.97
Tropical juices	−2.24*	2.09*	0.94	0.35*	0.95
Other nontropical fruits	−1.38*	1.73*	0.97	1.12	0.95
Other tropical fruits	−1.50	1.39*	0.10	0.64*	0.97
Treenuts	−0.54	0.71*	0.66	0.69	0.95
Total	0.51*	0.95*	0.98	0.94*	0.99
Vegetables					
Fresh	−0.57*	0.84*	0.91	1.29*	0.91
Roots and tubers	−0.50*	0.93*	0.78	0.30*	0.95
Hops	−2.72*	5.89*	0.29	1.86*	0.29
Miscellaneous vegetables	−0.52*	0.89*	0.92	1.20*	0.93
Processed	−1.41*	2.04*	0.93	0.62*	0.92
Roots and tubers	−1.00	−2.09*	0.34	. . .	. . .
Pulses	−0.33	0.75*	0.60	0.40*	0.77
Miscellaneous vegetables	−1.29	3.34*	0.98	1.53*	0.98
Total	−0.82*	1.16*	0.93	0.87*	0.94

* = significant at the 95 percent level.

** = significant at the 90 percent level.

products as in fresh products. Between the different groups of fruits and vegetables, processed nontropical juices (6.97) in fruits and processed miscellaneous vegetables (3.34) in vegetables are the highest.

The estimated price elasticities in the export supply equation are significantly positive in most equations, which suggests that export supply for horticultural products in developing countries responds to price incentives. The estimated export price elasticity of supply is 0.94 for fruits and 0.87 for vegetables. The estimate is less plausible for processed vegetables (0.62), since it is much smaller than that of fresh vegetables (1.29), which is highly unlikely. However, the size of the price elasticity for miscellaneous processed vegetables alone, which composes more than half of the processed vegetables category, is larger than that of fresh vegetables. In fruits, the estimate is higher for the processed products and tends to be higher for temperate-zone processed fruits than for tropical processed fruits. The supply elasticity of oranges (1.42) is highest among the fresh fruits, whereas elasticities of bananas (0.53) and tropical fruits (0.48) are low.

It is widely accepted that the equation for specification of supply presents a difficulty: the performance of the equation is often too poor to generate reliable estimates of supply elasticities. Therefore, findings of different studies are more difficult to compare for supply equations than for demand equations.

The estimates of supply elasticities obtained here for fruits and vegetables are higher than those found for traditional agricultural commodities in past studies. For example, the supply elasticity obtained by Bond (1987) fell in the range of 0.43 for agricultural raw materials to 0.70 for food, which is still higher than the results in other studies. The evidence that horticultural products are more price responsive than other agricultural commodities is very encouraging for those developing countries that have an interest in the potential for horticultural exports to increase their overall agricultural exports. Therefore, more detailed information about price and income elasticities for individual commodities, relevant to individual countries, is needed to analyze the effect of changes in domestic prices, foreign prices, and foreign income on a country's exports.

5

TRADE BARRIERS AGAINST HORTICULTURAL EXPORTS AND THE EFFECTS OF POSSIBLE LIBERALIZATION

Horticultural exports of developing countries are constrained by tariff and nontariff barriers in importing countries. Since developing countries send an overwhelming proportion of their horticultural exports to developed countries, the trade restrictions imposed are of crucial importance to the expansion of developing-country exports. In general, tariffs on horticultural products vary by product, season, and country of origin. But tariffs may also depend on more specific differences, such as the packaging unit, the content of sugar or other ingredients, or the stage of processing. In the case of nonstorable horticultural crops such as fresh vegetables and fruits, seasonal tariff rates are often applied. In other words, higher tariffs are placed on imports during the seasons when they compete with domestic products. A wide range of nontariff barriers also affect trade in horticultural products. They include quotas, voluntary export constraints, variable levies, minimum price systems, countervailing taxes and duties, technical specifications (especially health restrictions and strict labeling and packaging specifications), and even bureaucratic delays and uncertainties.

Tariffs

Table 21 briefly summarizes effective tariff rates in selected developed countries that prevailed during the period of the post-Tokyo Round. This table provides separate tariff rates for vegetables and fruits and for fresh and processed items within each category. Of the three major importers in the developed world, the European Community, Japan, and the United States, Japan had the highest effective tariff rates in all categories. The European Community had the second highest rates on fresh fruits and processed vegetables, whereas the United States was second for fresh vegetables and processed fruits. The effective tariff rates on processed fruits were almost the same in Japan and the United States.

Furthermore, the effective tariff rates on processed fruits and vegetables were higher than those on fresh vegetables and fruits, sometimes significantly higher. For example, in the United States, processed fruits had an effective tariff rate of 20 percent or more, while the rate on fresh fruits was only 1 percent.

The average rates quoted in Table 21, however, conceal a wide disparity in tariffs on different kinds of fruits and vegetables and among various countries. This is evident for fruit juices in Table 22, where the tariff of the United States was 52 percent, Australia's was 29 percent, Japan's, 24 percent, and the European Community's, 7 percent. Similarly, for potatoes, tomatoes, and onions, the United States had the highest duty rates at 17 percent, followed by the European Community and Canada. In tropical fruits and nuts, which do not compete with the products of the industrialized countries, most of the developed countries had low duty rates. Japan was the exception with rates as high as 33 percent, compared with Switzerland at 16 percent.

The United States, more than any other country, levied specific duties rather than

Table 21—Effective tariffs in developed countries, post-Tokyo Round

Country	Vegetables		Fruits	
	Fresh	Processed	Fresh	Processed
	(percent)			
European Community	6.7	15.1	7.7	16.6
Japan	9.0	17.5	21.5	21.8
United States	7.6	11.0	1.1	20.3
Other developed nations	0.1 ~ 14.0	5.7 ~ 14.6	0.0 ~ 10.7	0.7 ~ 13.7

Source: Alexander Yeats, "The Escalation of Trade Barriers," in *The Uruguay Round: A Handbook on the Multilateral Trade Negotiations*, ed. Michael J. Finger and Andrzej Olechowski (Washington, D.C.: World Bank, 1987), p. 119.

Note: Effective tariff rates measure the influence of protection on value added in a production process.

ad valorem duties on a number of products. Thus duties were related to the quantity of the product imported, rather than its value, with the consequence that the duties were higher on low-value than on high-value products.

The duties not only varied widely among the different importing countries and commodities, but the rates varied depending on the source of the import. Lower tariff rates were applied to countries that had preferential arrangements with the major importing countries. For example, the United States had an agreement with the Carib-

Table 22—Average post-Tokyo Round tariff levels in selected major industrial countries on imports of selected horticultural products from developing countries

Commodity Group	United States	Canada	European Community	Japan	Australia	New Zealand	Austria	Switzerland
	(percent)							
Potatoes, tomatoes, and onions	17.1	6.7	13.2	5.8	0.5	. . .	0.4	0.3
Vegetables, frozen	8.3	19.1	17.8	10.0	0.6	. . .	. . .	21.4
Vegetables, preserved	15.8	0.3	2.0	15.0	8.4	. . .	3.4	3.9
Vegetables, preserved by vinegar	4.4	16.0	3.6	12.7	12.0	10.0	21.7	6.7
Vegetables, preserved, n.e.s.	11.3	10.3	8.5	21.6	14.9	0.7	11.4	3.1
Vegetables, dried	2.3	12.5	10.6	12.3	16.3	0.6	1.1	. . .
Beans and peas	1.8	0.3	0.2	3.3	7.8	. . .	. . .	0.3
Tropical fruits and nuts	0.2	. . .	5.8	33.2	0.1	. . .	0.1	15.6
Citrus fruits	6.7	. . .	4.4	12.2	. . .	. . .	6.0	8.1
Raisins	11.3	. . .	. . .	5.0	. . .	. . .	2.4	6.5
Other nuts, n.e.s.	2.3	. . .	2.5	14.9	0.7	. . .	2.4	2.7
Apples and pears	0.7	1.1	3.6	12.4	. . .	. . .	2.9	4.2
Fruits preserved by sugar	3.1	0.4	. . .	16.0	9.6	29.7	18.3	8.8
Jams and jellies	6.6	5.5	12.4	27.9	13.4	. . .	. . .	10.1
Nuts and fruits, roasted or preserved	1.8	0.4	6.2	27.0	4.8	28.9	9.3	12.5
Fruit juices including orange	51.9	0.2	7.1	24.2	28.9	1.0	8.6	11.6

Source: United Nations Conference on Trade and Development (UNCTAD), *Agricultural Trade Expansion and Protectionism with Special Reference to Products of Export Interest to the Developing Countries* (TD/B/C.1/239), 1983, Annex, pp. 6-7.

Notes: n.e.s. is "not elsewhere specified." Ellipses (. . .) indicate little or no tariff on a product.

bean countries, and the European Community had one with the African, Caribbean, and Pacific (ACP) states. A few developed countries placed preferential rates on imports from a large number of developing countries under the Generalized System of Preferences (GSP).

Although most industrialized countries imposed low rates on tropical fruits and vegetables, there were wide differences between commodities and countries. For example, tropical nuts such as coconuts, cashews, and Brazil nuts, fresh or dried, were duty-free in many countries. But duties were imposed on some tropical nuts, including macadamia, betel and cola nuts, by Austria, Japan, Switzerland, the European Community, and the United States. Although, in general, duties on tropical fruits such as pineapples, mangoes, and avocados were somewhat low, this was not true in the United States for avocados, for example, where duties were as high as 76 percent because domestic products compete with imports. Papayas, guavas, and other fresh tropical fruits also faced duties in the markets of Japan, Switzerland, the European Community, and the United States.

The level of protection sometimes differed depending on the percentage of sugar content or the degree of processing and packaging. For example, consumer-packed juices in cans, bottles, or cartons were charged higher duties than bulk-packed fruit juices, even though the volume of trade in consumer-packed juices in developing countries was relatively small due to higher freight and packaging costs.

Nontariff Barriers

A wide-ranging set of nontariff barriers (NTBs) affects the horticultural exports of developing countries. One way of indicating the intensity or the extent of NTBs is to quantify the number of items that are subject to them. Data from UNCTAD (1984) indicates that in industrialized countries, 39 percent of fresh vegetables and 20 percent of fresh fruits were affected by NTBs. The incidence was more frequent for processed products; 48 percent of processed vegetables and 54 percent of processed fruits were subject to such barriers. The restrictive effect of NTBs on horticultural imports was considerably greater than that of tariffs, as indicated by the price spread between domestic and import prices that is created by NTBs. For example, the differentials between the import price and domestic price due to NTBs on vegetables and vegetable products ranged between 30 and 80 percent, whereas the corresponding price differentials due to nominal tariffs ranged between 7 and 13 percent. For edible fruits and nuts, price differentials due to NTBs ranged from 22 to 180 percent and for nominal tariffs, from 4 to 14 percent (UNCTAD 1984, 201).

Some of the NTBs that restrict horticultural exports of developing countries include the following. First, all major importers of horticultural products maintain a system of marketing orders that serve to regulate and protect their domestic production, These systems differ widely in their restrictive effects on horticultural trade. Marketing orders frequently specify size, grade, quality, and the desired degree of maturity or ripeness of produce.[20] Abrupt changes in the quality and packaging requirements imposed by an importing country are sometimes introduced to reduce imports. Such an incident is reported by Bredahl, Schmitz, and Hillman (1987) for exports of Mexican tomatoes to the United States. Many countries require import licensing for imports of horticultural products, which increases the transaction costs in import trade. For example, the European Community and Japan apply this to all imports of processed vegetables, nuts, and fruit juices. Austria, Finland, New Zealand, Norway, and Switzerland use discretionary licensing for horticultural imports.

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[20] In the early 1980s, U.S. marketing orders covered all or part of U.S. production or sale of 33 different fruits, vegetables, and nuts (Jesse and Johnson 1981).

Second, quotas and voluntary trade restrictions are also used quite often in horticultural trade. For example, the following products are subject to quota restrictions in the European Community (GATT 1988).

Product	Country
Bananas	France, United Kingdom, Italy, Portugal, Spain, Greece
Pineapples, fresh or dried	Spain, France, Portugal
Other fresh tropical fruit	Spain, France, Greece
Provisionally preserved fruit, jams, and prepared fruits	Portugal
Fruit juices	France, Italy, Portugal
Tomato paste from Turkey (preferential tariff)	European Community

Japan imposes import quotas on citrus fruits, orange and grapefruit juices, prepared pineapples, dried peas and beans, and some other processed items (GATT 1988). Finland and Norway apply quotas on sweetened pineapple juice. The United States imposes quotas whenever imports materially inflict or threaten to inflict damage on price support programs. France controls its imports through a national organization that reserves two-thirds of its market to French overseas departments (Martinique and Guadeloupe) and the remaining one-third to ACP countries, mainly Cameroon, Côte d'Ivoire, and Madagascar (GATT 1988).

Third, subsidies and price supports are also provided for horticultural products, along with other agricultural products, in Canada, Japan, the European Community, and the United States. For example, the European Community subsidizes various processed tomato products, canned peaches and mixed fruit, dried plums, dried figs, sultanas, and currants (Bale 1986, 10-11).[21] In 1986, about 30 percent of processed fruits received a production subsidy, which applied to about 15 different products. The total subsidy on the production of processed products equaled the annual value of the raw products before the subsidy was introduced. Export rebates are also provided for products that do not receive production subsidies, such as walnuts, almonds, and hazelnuts. Tomato products in the European Community receive price supports, subsidies on domestic processing, and export subsidies, thus intensifying EC competition in the world market for tomato products, and making it more difficult for the newly emerging exporters in the developing world to increase their share of the market.

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[21] Many horticultural products in the European Community are included in the Common Agricultural Policy and therefore subject to a whole range of interventions including variable levies, reference prices, and export and production subsidies. For example, 50-60 percent of total EC supplies of fresh fruits and vegetables are covered by a reference price system. The production subsidies for some processed fruits and vegetables have increased supplies in the EC countries at the expense of third-country products. The application of the reference price system has prohibitive effects on imports of cucumbers and tomatoes in the European Community during the spring and autumn seasons. See also Alvensleben 1982.

The processing industry in Japan also is subsidized. Canada supports prices of selected fruit and vegetable products through deficiency payments and government purchases. Moreover, horticultural producers benefit from advanced payments, crop insurance programs, and subsidized storage and packaging facilities. Farm credits, loan programs, and irrigation subsidies are available to U.S. farmers.

In view of a higher incidence of protectionism on cereals and livestock products than on horticultural products, and in view of pressure from the Mediterranean EC countries to harmonize the level of protection, there is political pressure in the European Community to increase the levels of production subsidies on fruits and vegetables (Alvensleben 1982). In 1986, for example, the list of horticultural products under the reference price and intervention system was expanded. The inclusion of Portugal and Spain, with their large potential for exports of horticultural products, may further increase the pressure in this direction.

Fourth, the regulations that protect people from unsafe and unsanitary food and prevent the spread of plant diseases (phytosanitary regulations) constitute an important class of nontariff barriers in horticultural trade. They represent a complex system of specifications enforced by national and multinational plant quarantine and food sanitary laws.[22]

It is hard to distinguish unnecessary restrictions from real ones because standards and safety concerns with respect to food sanitation and disease infestation differ widely among countries. For example, regulations that result in mandatory fumigation may render imported products (such as citrus fruits) unmarketable if facilities for fumigation are unavailable. Furthermore, national standards and regulations change from time to time, sometimes abruptly or without prior notice, so that a country that is oriented toward meeting the food standards of an importing country on the basis of past practices and rules may find their exports unacceptable unless they undertake changes to meet the new standards. This creates uncertainty in export markets.

In 1984/85, for example, imports of pineapples from Mexico into the United States fell as the result of regulations on tolerance levels for residues of the pesticide, carbaryl. Again, mango imports from Mexico and Haiti into the United States suffered a setback in 1985 with the introduction of U.S. fumigation regulations to eliminate residues of the pesticide, ethylene dibromide (EDB), used to control fruit flies.[23]

In general, the application of different health standards for domestic and imported goods is an indication of discrimination against imports. Phytosanitary regulations can be characterized as trade barriers if they are very restrictive compared with those commonly applied by other countries. In Japan, for example, imports of 13 fresh fruits and vegetables are prohibited because of plant quarantine restrictions. Among the 13 are important items like apples, apricots, eggplants, nectarines, peaches, green peppers, potatoes, and tomatoes. The European Community has a general agreement on phytosanitary restrictions for horticultural trade between EC countries. For other trading partners, each EC country sets its own regulations, which differ by country of origin, commodity, and season.[24] Imports of all fresh fruits and vegetables to the United States are restricted unless specifically approved under the plant protection and quarantine regulations.

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[22] The provisions of national food standards and regulations differ from one another in a variety of ways, ranging from composition to labeling, and these differences can obstruct the flow of international trade. If a common set of import requirements could be agreed upon, exporters could quickly transfer exports to the country where market conditions are most favorable, without concern about meeting different import requirements. Moreover, harmonization of standards would avoid the cost of reformation of products and labels to meet varying requirements. Finally, such an agreement would eliminate the drawing up of severe and unreasonable regulations for the purpose of erecting obstacles to exports from third countries (GATT 1988, 11).

[23] In 1985 U.S. regulations established a zero tolerance level, which would have eliminated all imports of fresh mangoes. A temporary tolerance level (30 parts per billion) was reestablished in early 1986 to allow imports, while efforts were made to develop alternatives. Later a treatment entailing a double dip of hot water was developed, and mango imports received approval (FAO 1987a).

The United States imposes phytosanitary regulations as defined by the U.S. Food and Drug Administration. In the exporting country, the produce has to be analyzed by an independent laboratory at the cost of the trading partners. For most of the trade items and most importers, a phytosanitary certificate has to be provided and laboratory tests have to be conducted for up to 20 different plant diseases. Regulations and specifications tend to become increasingly complex over time (FAO 1987a).

Reasons that a fruit or a vegetable may not be approved for entering into the United States are as follows: (1) The Plant Protection and Quarantine Service has not studied the risk of importing that item, and no imports have taken place in the past; (2) the Service refuses to issue a permit because the item presents too great a pest risk; or (3) government agencies other than the Plant Protection Service may restrict entry due to noncompliance with standards of tolerance for pesticides and of fumigation of agricultural products. For example, in 1985 the Environmental Protection Agency eliminated the tolerance limits for inorganic bromide for a variety of fruits and vegetables. The U.S. Food and Drug Administration sets up registration and thermal process filing requirements for all low-acid canned foods; it also sets up requirements for all food additives and packaging materials.

There are also regulations regarding packaging and labeling of horticultural products. The packaging unit of processed products (can, box, other container) has to be labeled according to the laws of the importing country. For example, Canada and Japan require special labeling measures for fruits prepared by acetic acid. With growing concern about effects on health and safety of pesticide residues and processing chemicals, food, health, and labeling specifications are likely to expand.

To meet these requirements, the developing exporting countries have to set up expensive, high technology laboratories. This may also explain why the major exporters of horticultural products among the developing countries are mostly middle-income countries. Education, training, and a sophisticated level of technological infrastructure are needed to monitor phytosanitary conditions of horticultural products for export.

In an effort to harmonize the phytosanitary regulations of importing countries, a number of international organizations, notably FAO, the World Health Organization (WHO), and the Organisation for Economic Cooperation and Development (OECD), are defining international standards concerning nutrition, labeling, additives, contaminants, and pesticide residues.[25] If national standards can be harmonized, with the guidelines formulated through international consensus, it is expected that regulations and their purposes will become clear so that obviously protectionist components may be detected.

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[24] For example, in the Federal Republic of Germany, the dominant importer of fruits and vegetables in the European Community, all vegetables except potatoes can generally be imported. Fresh fruits have to be free of San José scale *(Quadraspidiotus perniciosus)* and the Mediterranean fruit fly *(Ceratitis capitata)* (GATT 1988, 1-4).

[25] The Codex Alimentarius Commission (Codex) jointly organized by FAO/WHO has developed standards for a number of processed fruits and vegetables, including juices. For example, Codex international standards exist for pineapple products but not for mango products such as mango juice or canned mango. The Codex standards are not accepted by all countries as part of their national regulations and standards. Similarly, EC standards for pesticide residues are not uniformly accepted by member countries (GATT 1988).

A developing country that wants to export a not-yet-established product often exports it through an agent in the importing country, who handles the distribution and marketing without any financial risk but for a commission. The exporter bears the entire risk. The risk is shared by the importer only when trust has developed over time between the importer and the exporter. Thus, commission sales play an important role in developing new export markets. Regulations that in some countries prohibit commission sales and require that horticultural imports must have a prearranged buyer tend to inhibit new, nontraditional exporters.

Effects of Enlargement of the European Community on Horticultural Trade of Developing Countries

The integration of Greece, Portugal, and Spain into the European Community—to be completed in 1990—is likely to affect the horticultural exports of developing countries. This is especially true for those products that the developing countries either export to the EC countries or sell in the world market in competition with the European Community.

Because the three new members are substantial producers and exporters of horticultural products, their integration affects not only the other members of the Community but also other countries that export horticultural products. The Mediterranean countries are likely to be most affected because the output composition of their horticultural exports is highly competitive with that of the new members. The new members, once fully incorporated into the system of domestic price supports of the European Community, including production and export subsidies, are expected to increase their production of horticultural products. Part of their increased output will find markets within the European Community and part in external markets. At the same time, EC countries are likely to divert their purchases from the non-EC countries to the member countries. The magnitude of the impact on world exports and hence on prices in world markets depends on many factors, such as the elasticity of output in new member countries, elasticity of export supply in other EC countries, long-run trends in export supply in and out of the European Community, as well as the elasticity of demand in the European Community and in the rest of the world. A study by Bale (1986) indicates that there is a possibility of downward pressure on prices due to an increase in supply relative to demand. Even though the overall effect on prices of horticultural exports is not likely to be large, price declines, and thus the adverse effects on export markets of individual products and commodities, may not be negligible.

A 1982 study estimated that the enlargement would have a substantial effect on exports of the Mediterranean countries (Cyprus, Egypt, Morocco, Tunisia, and Turkey) in the following commodities: vegetables, potatoes, onions, tomatoes, zucchini, tomato concentrates and juice, and fruits including watermelons, melons, citrus fruits, grapes, dried figs, raisins, canned olives, and apricots. The rest of the developing world would also be substantially affected in the following commodities: green beans, tomato concentrates, dried figs, and raisins (Alvensleben 1982).

The study by Bale (1986) estimates the extent of a possible decline in prices as a result of the EC enlargement in commodities. The range of decline in prices depends upon different assumptions regarding supply and demand elasticities. The higher range of price declines seems mostly to affect the vegetable products. For example, in the case of zucchini, eggplant, cucumber, and artichokes, the expected price declines (maximum range) are high (10-12 percent), whereas the growth rates for developing-country exports of these vegetables in 1975-85 have been very high (11-20 percent). The commodities that enjoyed the highest export growth rates in the past and that are predicted to have a high trend rate of growth of export supply in the future are likely to suffer the sharpest declines in prices. Two of the commodities that are expected to suffer price declines—strawberries and almonds—have already experienced a drop in the value of exports in 1975-85.

An associated question relates to the impact of the economic integration of Europe in 1992 on horticultural trade. To what extent it will affect the Common Agricultural Policy (CAP) depends partly on the agreements reached on the liberalization of agricultural trade under the Uruguay Round, which is scheduled to be completed by 1990. It is unlikely that the elimination of all border restrictions on trade within the EC countries by 1992 will have additional substantial adverse effects on the exports of developing countries, beyond what they have already sustained as a result of CAP. It is possible, however, that insofar as the processed horticultural products are concerned, the establishment of uniform standards relating to quantity and safety or a harmonization of such standards within the Economic Community will result in adoption of the standards of the country that has the strictest standards. This may adversely affect exports from developing countries, at least in the short run, if they are unable to adjust quickly to these standards.

Effects of Trade Liberalization

The consequences of reduction in trade barriers in Japan, the European Community, and the United States, the leading importers of horticultural products from developing countries, are assessed in this section. A partial equilibrium approach is used, although such an approach cannot analyze the economy-wide or secondary effects of trade liberalization, including exchange rate changes. Nevertheless, its use is justified in view of the small share held by the horticultural sector in agriculture and in the overall economy. In spite of their limitations, these estimates provide some indication of the orders of magnitude.

The liberalization of trade barriers by developed countries would increase both the quantity of world exports and a rise in world prices. If the supply is infinitely elastic, however, only the quantity of world exports would expand, and prices in the world market would be unchanged.

Following the liberalization of trade, consumers and producers in the developed countries will face a decline in domestic prices, leading to an adjustment in both domestic consumption and production and therefore to a change in net trade. A rise in the world price confronting producers and exporters in the developing countries will have the opposite effect; domestic production will be stimulated and consumption will be discouraged, leading to a rise in exports.[26]

The consequences of trade liberalization through a reduction in tariffs are estimated for four major categories of horticultural exports: fresh vegetables, processed vegetables, fresh fruits, and processed fruits. Insofar as the analysis of the reduction in the NTBs is concerned, data on the nominal equivalents of NTBs are not readily available. Some estimates for total fruits and total vegetables, without a distinction between fresh and processed products, are available for Japan and the United States. For the European Community, estimates are only available for France, and these are assumed to be valid for the Community as a whole.

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[26] The model used for estimation of the effects of liberalization is described in Appendix 2.

Estimates of import demand and export supply elasticities are critical for assessing the effects of liberalization of trade. Information on the relevant elasticities for horticultural products is scarce, and information on export supply elasticities is even more scarce. Hence, a sensitivity analysis is used in these exercises, that is, a range of elasticities are used for both import demand and export supply. Many studies on the effects of trade liberalization on agricultural products assume that export supply elasticity is large on the basis that exports are frequently a small proportion of aggregate domestic production. However, it is pertinent that, for all categories of horticultural products, those sold in the domestic market are not close substitutes for those exported, especially in quality. Furthermore, while the elasticities of import demand and export supply may be high for individual horticultural products, they are unlikely to be so for large groups of products or for total horticultural products. In this exercise, it is assumed that import and export demand elasticities vary between 0.5 and 1.0, following the results of the price elasticity estimation in Chapter 4. They are broadly in line with estimates for individual groups of horticultural products made in various studies, as reported in Appendix 2.

The alternative estimate of the increase in export revenues based on different assumptions regarding the export supply and import demand elasticities is presented in Table 23. The maximum increase in earnings from total horticultural exports resulting from the elimination of tariffs by the United States, the European Community, and Japan is estimated to be 9 percent. If NTBs were totally eliminated, the maximum increase in export earnings is estimated to be about 36 percent. The minimum increase in export earnings is 6 percent due to elimination of tariffs, and 24 percent due to elimination of NTBs. This assumes that NTBs are the dominant import constraint and that tariffs are not effective under NTBs. The effect of the elimination of the NTBs—the total price differential between the import and the domestic price—already subsumes the effects of the elimination of tariffs. Therefore, the effects of the elimination of tariffs are not additive. Although some individual commodities are only subject to tariff barriers (not NTBs), it is assumed that the tariff and the NTBs prevail simultaneously at the group level of horticultural products or total horticultural products, and that the latter is the effective trade barrier.

Under the scenario where tariffs are eliminated, the percentage increase in export earnings is higher for fruits than for vegetables. That also holds true for fresh fruits compared with fresh vegetables and for processed fruits compared with processed vegetables.

Sixty-eight percent of the total increase in export earnings following the elimination of tariffs is accounted for by fruits primarily because a much larger quantity of fruits are exported than vegetables. But 62 percent of the total increase in export earnings is accounted for by processed horticultural products, primarily because duty rates on processed products are higher.

Eighty percent of the increase in total earnings consequent to the elimination of the NTBs is accounted for by fruits because the incidence of NTBs is much higher in fruits, and the initial quantity of exports of fruits is higher.

The maximum increase in the export revenues of the developing countries is estimated at US$850 million if only tariffs are eliminated, and at US$3.3 billion if the NTBs are also eliminated. The question may be raised, however, as to whether the

Table 23—Increase in export earnings as the result of liberalizing trade by removing tariff and nontariff barriers, 1983-85

Commodity Group	Import Elasticity	Export Elasticity	
		0.5	1.0
		(US$ million)	
With tariffs removed			
Fresh vegetables	−0.5	45 (3)	57 (4)
	−1.0	54 (3)	75 (5)
Processed vegetables	−0.5	108 (5)	136 (6)
	−1.0	136 (6)	193 (9)
Total vegetables (fresh and processed)	−0.5	153 (4)	193 (5)
	−1.0	190 (5)	268 (7)
Fresh fruits	−0.5	183 (6)	173 (5)
	−1.0	235 (7)	250 (8)
Processed fruits	−0.5	237 (11)	246 (11)
	−1.0	287 (14)	334 (16)
Total fruits (fresh and processed)	−0.5	420 (8)	419 (8)
	−1.0	522 (10)	584 (11)
Fresh fruits and vegetables	−0.5	228 (5)	230 (5)
	−1.0	289 (6)	325 (7)
Processed fruits and vegetables	−0.5	345 (8)	382 (9)
	−1.0	423 (10)	527 (12)
Total fruits and vegetables	−0.5	573 (6)	612 (7)
	−1.0	712 (8)	852 (9)
With nontariff barriers removed			
Vegetables	−0.5	391 (10)	469 (12)
	−1.0	499 (13)	677 (18)
Fruits	−0.5	1,830 (35)	1,680 (32)
	−1.0	2,480 (47)	2,590 (49)
Total fruits and vegetables	−0.5	2,221 (24)	2,149 (24)
	−1.0	2,979 (33)	3,267 (36)

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: Numbers in parentheses are percentage changes.

increase in export earnings is overestimated, because these estimates do not take into account that the exports from the ACP countries to the European Community and from the Caribbean Basin Initiative (CBI) countries to the United States are currently duty-free, and in many cases also free from nontariff barriers. However, the share of CBI countries in total horticultural imports of the United States is no more than 3 percent (USDA 1988, 8-11). Similarly, in the case of the European Community, most of the ACP countries are not important exporters of horticultural products. Among the 31 major exporters, only two are from the ACP group—Côte d'Ivoire and Kenya. The ACP countries as a whole do not contribute more than 12 percent of total horticultural imports of the European Community from the developing countries (Stevens and Themat, 1987). Therefore, estimates of increases in export earnings are not significantly different, even if the restriction-free access of ACP exports to the European Community is taken into account.

Estimates of increases in export earnings following a liberalization of trade by the major developed importing countries may be compared with similar estimates given in other studies for selected horticultural products or groups of products. A recent study by UNCTAD of selected horticultural products or groups of products (13 groups) provides the following estimates of the percentage increase in export earnings over the 1980 value of imports as the result of liberalization by the United States, Japan, and the European Community (UNCTAD 1985, 213).

	Percent
Selected fresh products	7
Selected processed products	18
Average of the two groups together	15

These estimates include the result of the elimination of tariffs and NTBs. The largest increases were in processed fruits and nuts (40 percent), fruit and vegetable juices (33 percent), vegetable products (12 percent), and processed vegetable products like potatoes (24-26 percent). The figures above represent the weighted average of 13 selected commodity groups only—not all horticultural products. The size of the price differential accounted for by the NTBs is unknown. However, import demand elasticities are assumed to vary between 0.6 and 0.4. The export supply elasticities are not given.

An alternative analysis of the effects of liberalization on seven selected horticultural products yields estimates of increases in export earnings ranging from 52 percent for potatoes to 4 percent for bananas. The weighted average increase in the export earnings for the seven commodities is 13 percent.[27] However, most of the products included are fresh, which have a lower level of barriers or restrictions.

The estimates of the increase in export earnings resulting from the elimination of the NTBs, as given above, are likely to be biased upward, even though the export supply elasticities assumed in the present exercise are lower than what is normally assumed in other studies of this kind. However, the results are much more sensitive to variations in demand elasticities than those in supply elasticities. There are several reasons why an upward bias is probable. First, without data on the NTBs on individual fruits and vegetables or on fresh products as distinguished from processed products, the price differentials used in this exercise relate only to two broad groups of horticultural products. Furthermore, the measures of price differentials used in the study do not include all fruits and vegetables, even though they are deemed to represent the price differentials for other commodities as well. From limited evidence, it appears that the items excluded have smaller price differences than the items included.

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[27] The import demand elasticities vary within a wide range in the study—from −7.6 for potatoes to −0.4 for bananas, for example. Export supply elasticities are assumed to be consistently higher than import demand elasticities; they range from 9.5 for grapes to 1.7 for bananas. It should be noted, however, that the consequences of liberalization indicated here refer to all OECD countries, not limited, as in the present study, to the European Community, Japan, and the United States. The increases in export earnings over 1977 from each of the seven horticultural products are as follows: potatoes, 53 percent; apples, 23 percent; grapes, 76 percent; lemons and limes, 19 percent; dry beans, 7 percent; oranges, 6.4 percent; bananas, 4.3 percent; and shelled peanuts, 4 percent.

Second, the average price differentials for groups of commodities are unweighted. Since the subgroups with higher price differentials are likely to have smaller volumes of import or export because they have a greater restrictive effect on trade, the unweighted averages are likely to be higher than the weighted averages.

Third, the price differential for France is used for the European Community, since data for the European Community as a whole is not available. France seems to have higher NTBs than other members of the European Community. It should also be noted that the price differentials due to NTBs vary significantly from year to year, depending upon the world prices. The price differentials used in the study relating to the mid-1970s may not truly represent the current situation. In spite of these limitations, however, the estimates indicate a broad order of magnitude for increases in export earnings flowing from liberalization of trade in horticultural exports of developing countries.

Liberalization of Trade Between Developing Countries

The foregoing discussions have focused on the import restrictions of developed countries and their consequences for the exports of developing countries. Although developing countries account for only 17-18 percent of world imports, they have increased their share of world trade. Furthermore, they also impose restrictions on imports of horticultural products. A liberalization of such restrictions would stimulate imports and constitute an expansion of world trade, in which exporting developing countries are expected to share.

Developing countries imposed both tariffs and NTBs on their imports of horticultural products in 1981. The structure of tariffs on four different classes of horticultural products in 1981 is shown below, along with the share of developing countries in total imports of each category (Laird and Yeats 1988).

Commodity Group	Tariff Rate	Share of Imports from Developing Countries
	(percent)	
Fresh fruits	47.1	57.3
Processed fruits	73.3	27.3
Fresh vegetables	39.3	41.4
Processed vegetables	48.2	15.6

First, the tariff rates imposed by developing countries were five-to-eight times higher than those of developed countries, and tariff rates on processed products were higher than those on fresh products. Fruits escalated more than vegetables, but in general the degree of escalation was less than that of the developed countries. The tariff rates imposed by developed countries on processed vegetables were about 50 percent higher than those on fresh vegetables, but in the developing countries, they were barely 20 percent higher. For processed fruits, the tariffs of developing countries were 50 percent higher than those on fresh fruits, whereas in the developed countries, the rates were almost three times higher.

The proportion of imports obtained from other developing countries was much higher for fresh than for processed fruits. About 70-85 percent of imports of processed products were obtained from developed countries.

NTBs were also quite high in the developing countries. Table 24 indicates the nature and intensity of quantitative restrictions placed on horticultural imports for a sample of developing countries and commodities.

What is the possible magnitude of the effect if developing countries eliminate tariff barriers on their imports from other developing countries, that is, if they engage only in intradeveloping-country trade liberalization? It has been estimated that they are likely to increase their imports by 7-8 percent over 1981.[28] Since the developing countries' share of imports is 49 percent for all fruits and 35 percent for vegetables, the liberalization only applies to a small share of the import trade on a preferential basis. In other words, the tariff barriers on the rest of their imports, derived from developed countries, are not eliminated. Furthermore, it should be noted that the estimates of increased trade relate only to the elimination of tariff barriers and not to NTBs, which remain unchanged.

Horticultural Products in the Uruguay Round

The prospects for liberalization of trade in horticultural products in the future are linked with the success of the Uruguay Round of the Multilateral Trade Negotiations.

The Uruguay Round of trade negotiations on agricultural commodities is carried out by two separate committees, the Committee on Agriculture and the Committee on Tropical Products. The latter explicitly includes seven product groups for negotiations; one of them is tropical fruits and nuts. There is no mention of other fruits or vegetables. This implies that other fruits and vegetables are covered by the Committee on Agriculture, if not by the Committee on Tropical Products. The distribution of the different agricultural commodities into two committees is a matter of negotiation between the contracting parties. The implicit understanding, at least in the early stages, was that the category defined as tropical commodities was of special interest to the developing countries; furthermore, with respect to most of these commodities, developed and developing countries did not compete much in world trade. Therefore, liberalization of trade could be undertaken to a greater extent and at a faster rate without adversely affecting exports or domestic production in the developed countries. As, at present, there is neither a strict definition of tropical products nor a set of criteria to establish one, it is possible that, as negotiations progress, additional commodities may be included, such as citrus fruits, in which developing countries compete with developed countries.

Two provisions of the GATT negotiating mandate, which are already agreed upon, are relevant in the context of liberalization of trade in horticultural products because

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[28] This estimate is based on the following assumptions: the elasticity of supply of exports for developing countries varies between one and infinity, and the elasticity of substitution between preference-receiving and other sources of supply is rather low, 1.5 percent.

Table 24—Quantitative import restrictions imposed by selected developing countries

Country	Commodities Banned or Under Quantitative Import Licensing Quotas
Brazil	Fruit and vegetable preparations
Colombia	Prunes
Ecuador	Fresh fruits
Venezuela	Apples, pears, raisins, and canned fruits
Egypt	Raisins, oranges, and almonds
Korea	Fresh fruits, nuts, vegetables, canned and frozen fruits
Indonesia	Fresh fruits, fruit juices, canned fruits, raisins and nuts
Philippines	Fresh apples, pears, grapes, oranges, limes and lemons, and other citrus fruits

Source: Based on data from USDA (U.S. Department of Agriculture), *Trade Policies and Market Opportunities for U.S. Farm Exports: Annual Report* (Washington, D.C.: USDA, 1987).

they cover items that fall under the category of tropical products, including bananas and roots and tubers (except cassava). According to UNCTAD's (1988) report on the Uruguay Round, "Negotiations shall aim at the fastest liberalization of trade in tropical products, including processed and semiprocessed forms, and shall cover both tariff and nontariff measures affecting trade in these products." And, "the contracting parties recognize the importance of trade in tropical products to a large number of less developed contracting parties and agree that negotiations in this area shall receive special attention, including the timing of negotiations and the implementation of the results" (UNCTAD 1988, 356). It is clear that tropical products are given priority status; thus accelerated negotiations and early implementation are indicated.[29]

Do the developed countries require reciprocity from the developing countries in negotiations on tropical products? Even though the case for separate and differential treatment for developing countries has been made in the Uruguay Round, so that developing countries are not expected to make concessions inconsistent with their development, trade, and financial needs, the more advanced developing countries will be expected to make reciprocal concessions. Even though tropical products are considered an area where reciprocity is less relevant, in the various trade liberalization offers already made by developed countries, reciprocity is expected from developing countries. However, it is implicitly understood that no equivalent concessions in terms of tariff reductions are expected. It is a question of relative reciprocity; the less-advanced developing countries will probably not be asked for any reciprocal liberalization. Furthermore, concessions given in other sectors may be considered in exchange for concessions received in this sector.

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[29] Following the GATT Midterm Review of the Uruguay Round in April 1989, the contracting parties agreed to pursue the following negotiations on the seven agricultural and tropical product groups: "(a) elimination of duties on unprocessed products; (b) elimination or substantial reduction of duties on semi-processed and processed products. These actions would include the objective of eliminating or reducing tariff escalations. (c) elimination or reduction of all nontariff measures affecting trade in these products" (GATT 1989). One of the seven product groups specified in this declaration is tropical fruits and nuts.

The GSP for developing countries is not important for agricultural commodities; it is relevant only for processed agricultural goods, including processed horticultural products. But these preferences are unilaterally and selectively given on a voluntary basis to designated countries and for specific commodities; they can be and often are withdrawn at the discretion of the preference-giving country. In light of the insignificance of these preferences, it is worth considering whether the developing countries are likely to derive a greater advantage from the elimination or substantial reduction of trade restrictions, both tariff and nontariff, on a most-favored-nation basis, than from a highly uncertain and limited preferential scheme affecting tariffs only. What is most important for the future growth of horticultural exports of developing countries is a liberal trade regime, and its stability and certainty over time, since many of the exports are new, having been introduced in world trade only in recent years. They require investment in export infrastructure, including marketing and distribution facilities. The prospects of future market development are likely to be brighter for processed products than for fresh. In this regard, tariff escalation or trade restriction increasing with the degree of processing is important. Without a substantial liberalization of trade in processed horticultural products, the future expansion of exports will be limited.

Regarding the demand for reciprocity by developed countries, the developing countries should seriously examine whether liberalization of trade among themselves on a preferential basis can be offered as a suitable reciprocal contribution on their part with respect to trade not only in horticulture but also in agriculture and manufactured goods.

The GATT negotiations on sanitary and phytosanitary regulations are particularly important for horticultural products. The GATT Midterm Review agreed to harmonize

> sanitary and phytosanitary regulations and measures on the basis of appropriate standards established by relevant international organizations; . . . also, to ensure transparency and the existence of an effective notification process for national regulations or bilateral agreements; to allow a consultation process which ensures an opportunity for the bilateral resolution of disputes; to improve the effectiveness of multilateral dispute settlement process; to provide necessary input of scientific expertise and judgment, relying on relevant international organizations (GATT 1989).

An important commitment is to "assess the possible effects on developing countries of the GATT rules and disciplines for sanitary and phytosanitary measures and evaluate the need for technical assistance" (GATT 1989). This is of particular importance to the developing countries in view of the crucial role of such regulations in determining the flow of trade in horticultural products.

6

FUTURE PROSPECTS OF HORTICULTURAL EXPORTS OF DEVELOPING COUNTRIES

The horticultural exports of developing countries have experienced dynamic growth since the 1960s. Although growth slowed in 1975-85, it was still higher than that of agricultural exports as a whole. What are the future prospects? This depends on the growth of demand in both developed and developing countries, and on the possibility of developing countries' maintaining or increasing their competitive strength in world markets.

The high income elasticity of demand for horticultural products has been frequently noted. In many developed countries, however, per capita consumption of horticultural products is quite high, and the prospects for further rapid expansion of demand are low. Even if the aggregate volume of consumption does not expand rapidly, it is likely that demand for imports of horticultural products from abroad, especially tropical products, may grow at a faster rate than aggregate demand for horticultural products. Because of the increasing trend toward diversification of the pattern of consumption of horticultural products, there is an increasing need for developing countries to explore and exploit the opportunities for exporting specialized products to developed-country markets—often directed toward particular consumer groups—by enhancing price competitiveness and improving quality. In many products the market is thin either because total trade volume is small or the number of transactions is limited. The market imperfections include oligopoly or monopolistic power in trade, with exports from a few countries exerting strong influence on market prices; economies of scale that constitute a barrier to entry of new exporters or competitors; steep learning curves for new entrants either in production techniques or in the handling, marketing, and processing of horticultural products; and cumulative advantages earned by early entrants in the export market or by established exporters from an early start in research, development, and innovations.

The developed countries will remain the largest market for horticultural exports, including those from developing countries. Export markets in developed countries are segmented for many products. The luxury market is that segment of the market that caters to high-income groups, including specialty restaurants. This market requires high-quality, fresh (in the case of fruits, full-ripe) fruits and vegetables, which fetch high prices. Produce is most often transported by air. Then there is the mass market for fruits and vegetables, which caters to the consumption needs of the middle-to-low income groups. These sell for lower prices, are predominantly transported by ship, and are frequently frozen or otherwise preserved. The price differential between the two categories may be large, often as much as 40-50 percent. For example, in the European market, pineapple from Kenya is a luxury item, whereas pineapple from Côte d'Ivoire is sold on the mass market (FAO 1985).

There are two additional market segments for tropical fruits. There is, first, a low-value market for fruits that are to undergo further processing for use as inputs in such final products as drinks, dairy products, and bakery or confectionery products. Second, there is the market for the higher-priced fresh, frozen, or processed fruits that are consumed directly. The requirements for packaging, labeling, and health standards are less stringent for the first market than for the second.

There is an additional distinction between off-season markets and year-round markets in developed countries. Horticultural products from developing countries have access to a larger, more open export market during seasons when the temperate developed countries are not producing their own fruits and vegetables. These seasons are short-lived, however, and imports in adequate quantity must be available at just the right times, which greatly depends on efficient transportation and distribution facilities in the exporting countries.

As was seen in an earlier chapter, regional markets or markets of neighboring countries assume more importance for horticultural exports, due to the high cost of long-distance transportation, the perishability of fresh products, and the similarity of tastes and consumer preferences. Measures to expand intradeveloping-country trade could play a critical role in future expansion of horticultural exports.

The market for most tropical horticultural products is now largely immigrant populations in developed countries, although it is slowly expanding to indigenous populations as the latter are exposed to the consumption habits of immigrant groups, partly through restaurants and foodshops. Imports of tropical horticultural products are higher in countries that have significant immigrant populations or historical links to tropical countries, such as past colonial relationships. The United States, the United Kingdom, Japan, and France are among the countries that fit this description, and they constitute the main markets for tropical horticultural products. Future growth of trade in tropical horticultural products will depend on how rapidly consumption spreads among the indigenous population. Education of potential consumers through promotional activities such as advertising holds the key to the future of such exports.

In a few cases, an increase in imports of horticultural products will result not from an expansion of aggregate domestic consumption but from substitution of imports for domestic production due to a shift in the consumption pattern away from traditional domestic products to new imported products. In Japan, for example, recent increases in imports of vegetables are not the result of an increase in the aggregate consumption of vegetables. Instead, the consumption pattern has diversified, with imported vegetables replacing domestically produced vegetables (Asian Vegetable Research and Development Center 1988, 152-170).

In light of these considerations, the potential for increased consumption and imports of horticultural products in developed countries can partly be gauged from the wide differences that currently prevail in per capita consumption of fruits and vegetables among individual countries. This is in spite of broad similarities in general patterns of food consumption, consumer preferences, and living standards. In Western Europe, for example, in 1983-85 per capita consumption of vegetables varied from a high of 221 kilograms in Italy to 180-192 kilograms in the United Kingdom and France and to 131-124 kilograms in Switzerland and Sweden. For individual vegetable products, per capita consumption varied widely: consumption of pulses, for example, was 3.7 kilograms in Italy, 1.9 kilograms in France, and 0.4 kilogram in Sweden. Per capita consumption of fruits varied from 140 kilograms in Switzerland to 131-116 kilograms in Italy and the Federal Republic of Germany and to 56 kilograms in the United Kingdom. Japan's per capita consumption of fruits, at 63 kilograms, was significantly lower than the average for Western Europe, at 102 kilograms, and for the United States, at 151 kilograms, the high (FAO 1985, Table 5.9).

It is expected that over time, countries with currently low per capita consumption of fruits and vegetables will increase their consumption in response to a rise in consciousness that plant protein is healthier than animal protein. Moreover, the desire to diversify the diet should lead to increased consumption as consumers become familiar with a wider variety of fruits and vegetables and more are available as the result of improved international transportation, distribution, and marketing systems. Sales promotion by marketing and distributing agencies or organizations in importing countries can contribute greatly to future expansion of demand (Commonwealth Agricultural Bureau 1980, chapter 5).

Two requirements are critical to future growth in exports of horticultural products from developing countries: first, efficient marketing infrastructure in the exporting countries, including reliable domestic and international transportation systems, and, second, close links with effective distribution systems in the importing countries.

Transportation is of paramount importance, especially where perishable products are concerned. They require suitable vehicles and containers and correct loading and storage facilities, so that quality is not adversely affected. Transportation costs constitute a large share of the total wholesale or retail price. The cost of airfreight for tropical fruits and vegetables frequently accounts for 30-60 percent of the sale price in the European market.[30] A reduction in the transportation cost would have a significant effect on prices and demand for horticultural products.

At the same time, the marketing and distribution margins are extremely high. For example, the retailer's margin above the buying price for imported products in supermarket chains in the United Kingdom is about 25-30 percent, whereas it is 50-60 percent in independent groceries.[31]

Airfreight continues to face such problems as lack of cargo space, unreliable capacity allocation, unsuitable itineraries, and inequality between inbound and outbound transport demand. And, even though technological advances such as precooling, refrigerated containers, and controlled atmospheric storage have improved seafreight, it still faces such problems as delay in transportation, long lead time for delivery, and lack of port facilities. The cargo capacity of a ship may be too large for the small volume of shipment of a particular horticultural product, and the possibility of combining various items for shipment is often not considered.

Close links with the distribution systems in importing countries are needed, in view of the concentration of trade in those countries and the tendency for shipping and sales schedules to be programmed well in advance. Such links are also needed to obtain precise information on the requirements of export markets regarding quality and packaging and to undertake promotional activities. Promotional activities are time consuming and expensive. The introductory period to familiarize consumers with a new product can extend over many years. During this period, imports are likely to be small.[32]

While the availability of market intelligence and knowledge of trade regulations are important factors in horticultural trade, there is no organized system of market intelligence for horticultural products comparable to what exists for other agricultural products. The International Trade Center (UNCTAD/GATT) provides an Interregional Multiproduct Market News Service to disseminate up-to-date information on prices, supply, and demand in importing countries that is far from adequate. The lack of basic information at the country level is a serious handicap because of the wide variety of items involved. The amounts of many items traded are so small that they do not attract adequate attention from the national trade intelligence and statistical services.[33]

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[30] Airfreight rates to Europe per kilogram are US$0.40 from West Africa, US$0.70 from Kenya, US$1.00 from Mexico, US$1.20 from Brazil, and US$2.50 from Southeast Asia (Joy 1987).

[31] This is especially true for imports of tropical fruits and vegetables from developing countries (Hallam and Molina 1988, 2-3).

[32] The success of two fruits—avocados and kiwi fruit—illustrates the importance of promotional activities. In 1985, Israel spent US$113,000 for advertising the avocado. Kiwi fruit had been known in the United Kingdom for many years under the name Chinese gooseberry without having significant market impact until New Zealand appropriated, renamed, and promoted it (Hallam and Molina 1988, 31).

Projections of Developing-Country Exports

To assess the future prospects of horticultural exports of developing countries, the following procedure is followed. First, aggregate demand for fruits and vegetables in the different regions of the world in the year 2000 is projected. Second, assumptions are made about the share of imports in the aggregate consumption of fruits and vegetables in different regions. Third, an assumption is made regarding the share of developing countries in world trade in the year 2000. The projections are made for the volume of exports in 2000 and the value of exports, which is derived from the unit price of exports for the period 1983-85.

The rates of growth of aggregate demand for fruits and vegetables in Table 25 are based on FAO projections of demand for the year 2000, on the basis of assumed rates of growth in income and population. Estimated income elasticities of demand are given in Table 26. Aggregate demand in the developed countries, including the centrally planned developed economies, is projected to grow by 1.6 percent a year for fruits and 0.8 percent for vegetables. The rates of growth in developing countries are projected at 3.5 percent for fruits and 2.9 percent for vegetables (Table 25).

Among the different commodity groups, fruits are projected to grow the most and vegetables the least in developed countries. However, when potatoes are excluded from the vegetable category, the growth rate for vegetables rises sharply.[34] It is worth noting that the projected rate of increase in the aggregate demand for fruits and vegetables (excluding potatoes) in developed countries is higher than that of cereals, coarse grains, and meat. The rate of increase in aggregate demand for horticultural products in developing countries is more than twice that in developed countries. Compared with centrally planned economies, the rate of growth in demand is 25 percent higher for fruits and 65 percent higher for vegetables (excluding potatoes). The rate of increase in aggregate demand for vegetables (including potatoes) was three-to-five times higher in developing countries than in either the centrally planned or market economy developed countries.

Differences in the rates of growth in demand are due partly to differences in projected income and population growth rates and partly to differences in income elasticities of demand, which are dependent on the level of per capita income and consumption reached in various country groups. At 1.9 percent, the projected population growth rate for developing countries is higher than that for developed countries. Among the developed countries, the population growth rate for North America, at 0.8 percent, is projected to be higher than that of Western Europe (0.2 percent). The income growth rate is projected to be higher for developing countries (4.9 percent) and for the centrally planned economies of Eastern Europe (3.7 percent) than for the developed market economy countries (3.3 percent) (Table 25). The assumed income elasticities of demand for horticultural products for the different country groups, along with per capita consumption in 1984, are shown in Table 26.

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[33] The signatories of the Lomé Convention between the European Community and the ACP countries have established an organization of European importers and exporters of fruits and vegetables, both tropical and off-season, which provides market intelligence services for both exporters and importers in member countries (FAO 1989b).

[34] Because potatoes are such a dominant part of total vegetable demand, two separate projections are made for vegetables—with potatoes and without.

Table 25—Projected annual rates of growth of aggregate demand, 1984-2000

Commodity	Developed Market Economies	Developed Centrally Planned Economies	Developing Countries
		(percent)	
Growth of aggregate demand			
All cereals	0.95	1.07	2.64
Coarse grains	1.06	1.22	3.40
Meat	1.00	1.32	3.85
Fruits	1.31	2.82	3.54
Vegetables	0.66	0.81	2.91
Vegetables, excluding potatoes	1.08	1.80	2.98
Population growth	0.60	0.70	1.90
GDP	3.30	3.70	4.90

Sources: Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome, 1988; and data on horticultural products compiled by the author from various FAO sources.

In general, demand elasticities are higher for fruits than for vegetables in all country groups. Elasticities are highest in the developing countries and lowest in the developed market economies. Per capita consumption of vegetables is similar in market economy countries and centrally planned developed countries, but consumption of fruit is much higher in the market economy countries. Per capita consumption of both fruits and vegetables is much lower in the developing countries, and, as incomes rise, significant increases in demand are expected to take place.

Based on estimates of the proportion of aggregate demand met by imports, two alternative import demand projections are made: one assumes that the 1984 ratio of imports to aggregate demand is unchanged, the other assumes that changes will continue in line with past trends in the import ratio since the 1960s. According to the first assumption, world import demand will rise 1.7 percent per year for fruits, 1.3 percent for vegetables, and 1.5 percent for vegetables excluding potatoes (Table 27). Under the second assumption, world import demand increases at a much higher rate: 3.1 percent per year for fruits, 3.9 percent for vegetables, and 4.0 percent for vegetables excluding potatoes.

Table 26—Income elasticities of demand and per capita consumption of horticultural products, by country group, 1984

Country Group	Income Elasticity of Demand		Per Capita Consumption	
	Vegetables[a]	Fruits	Vegetables[a]	Fruits
Developing countries	0.61 (0.30-0.90)	0.68 (0.28-1.17)	43.43	38.63
Developed market economy countries	0.25 (0.10-0.40)	0.38 (0.25-0.60)	101.00	92.95
Eastern Europe and U.S.S.R.	0.43 (0.30-0.60)	0.64 (0.34-0.82)	104.85	54.75

Source: Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome 1988.

Note: The numbers in parentheses indicate the range of variation in income elasticities of demand.

[a]Excludes potatoes.

Table 27—Projected annual rates of growth of aggregate and import demand for fruits and vegetables, by region, 1984-2000

Region	Growth Rate of Total Demand	Ratio of Imports to Demand		Growth Rate of Import Demand	
		Scenario I	Scenario II	Scenario I	Scenario II
			(percent)		
Fruits					
North America	1.34	26	29	1.34	2.09
Western Europe	1.01	22	29	1.01	2.67
Oceania	2.15	8	9	2.15	3.03
Japan	2.14	15	24	2.14	5.19
Eastern Europe and U.S.S.R.	2.82	8	10	2.82	3.92
Developed countries	1.64	18	23	1.37	2.82
Developing countries	3.54	3	3	3.54	4.50
World	2.68	...	...	1.73	3.09
Vegetables (including potatoes)					
North America	0.83	7	12	0.83	4.50
Western Europe	0.39	12	18	0.39	2.97
Oceania	1.23	3	6	1.23	6.17
Japan	1.43	4	12	1.43	9.41
Eastern Europe and U.S.S.R.	0.81	1	1	0.81	3.66
Developed countries	0.76	4	7	0.58	3.85
Developing countries	2.91	1	1	2.91	4.18
World	2.31	...	...	1.30	3.93
Vegetables (excluding potatoes)					
North America	1.07	10	18	1.07	4.89
Western Europe	0.85	17	22	0.85	2.60
Oceania	1.45	5	10	1.45	6.20
Japan	1.63	5	11	1.63	7.41
Eastern Europe and U.S.S.R.	1.80	2	2	1.80	2.97
Developed countries	1.32	9	13	1.02	3.60
Developing countries	2.98	2	3	2.98	5.02
World	2.47	...	...	1.54	3.96

Source: Calculated from data in Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome, 1988.

Notes: In Scenario I, a constant ratio of imports to demand in 1984 is used for projections. In Scenario II, trend functions are estimated to obtain the projected ratio of imports to aggregate demand in the year 2000.

A rise in the import ratio—the proportion of aggregate demand met by imports—is the main factor contributing to the increase in import demand of the major developed market economies (Table 27). Specifically, the increase in the import ratio of Japan is projected to be large, rising from 15 percent in the base year to 24 percent in the year 2000 for fruits and from about 4 percent to 12 percent for vegetables (with potatoes). In Eastern European countries, including the U.S.S.R., the ratio is projected to stay low. In all regions, the import ratio is much higher for fruits than for vegetables—as high as 29 percent in North America and Western Europe. However, the trend rate of increase in the import ratio is projected to be much higher in vegetables than in fruits, mainly because the import ratio for vegetables was low in the base year.

In this exercise, it is also assumed that world exports will expand to match the increase in world imports without affecting equilibrium prices in the base year. If developing countries maintain their current share in the quantity of world horticultural exports, the projected quantity of exports would vary between 28 and 37 million metric tons (Table 28). In other words, exports are projected to grow between 1.6 percent and 3.4 percent a year. Developing countries will export more than twice as many fruits as vegetables by the year 2000. The total value of exports is projected to range

Table 28—Quantity of developing-country exports projected to the year 2000

Commodity	Scenario I Quantity	Scenario I Annual Growth Rate	Scenario II Quantity	Scenario II Annual Growth Rate
	(1,000 metric tons)	(percent)	(1,000 metric tons)	(percent)
Fruits	19,713	1.73	24,380	3.09
Vegetables	8,154	1.30	12.289	3.93
Vegetables, excluding potatoes	7,445	1.54	10,852	3.96
Total fruits and vegetables	27,867	1.60	36,669	3.36

Source: Calculated from data in Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome, 1988.

Notes: It is assumed that world imports equal world exports. In Scenario I, a constant ratio of imports to demand in 1984 is used for projections. In Scenario II, trend functions are estimated to obtain the projected ratio of imports to aggregate demand in the year 2000.

from US$11.7 billion to US$15.4 billion in 1984 values, compared with an average value of exports of US$9 billion during the period 1983-85 (Table 29). Under the second scenario, however, the share of vegetables in total horticultural exports will rise substantially. The share of fruits in the total value of developing-country exports will be between 68 and 72 percent.

These projections of the value of the horticultural exports of developing countries are based on a constant share of developing countries in the volume of world trade of horticultural products and the unit price of exports during 1983-85. There is no significant trend in the share of developing countries in the volume of world trade in either fresh or processed horticultural products. The share of developing countries in the volume of world trade, however, varied between 32 and 42 percent during the period 1961-85.

Over the years the share of developing countries in the value—as distinguished from the volume—of world horticultural trade has increased, although the increase has only been significant during 1975-85. Developing countries' share of the value of world trade of processed horticultural products climbed consistently during 1961-85. But their share in the value of world trade in fresh products fluctuated; it declined during 1968-75 and then rose quickly, though never regaining the share held in 1968.

Therefore, the assumption that the share of developing countries in the volume of world trade will be constant is based on extrapolation of the past trend. Export promotion

Table 29—Value of developing-country exports projected to the year 2000

Commodity	Scenario I Value	Scenario I Annual Growth Rate	Scenario II Value	Scenario II Annual Growth Rate
	(US$ billion 1984)	(percent)	(US$ billion 1984)	(percent)
Fruits	8.5	1.73	10.5	3.09
Vegetables	3.3	1.30	4.9	3.93
Total fruits and vegetables	11.7	1.60	15.4	3.36

Sources: Calculated from data in Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome, 1988.

Notes: In Scenario I, a constant ratio of imports to demand in 1984 is used for projections. In Scenario II, trend functions are estimated to obtain the projected ratio of imports to aggregate demand in the year 2000. It is assumed that world imports equal world exports.

by developing countries could increase their share of the volume of world trade, but no assumption is made about this possibility or about the size of such an increase, and hence it is not incorporated into the analysis.

Assuming a constant unit value for exports may, however, not be plausible. If the share of processed products in the total volume of horticultural exports rises as it has over the past 25 years, the unit value of total horticultural exports will go up in the coming years. This is because the unit value of processed products is higher than that of fresh products. The assumption of constant unit value, therefore, may be modified to take account of the changing composition of horticultural exports. Based on past trends, the share of processed products in the total volume of horticultural exports is assumed to increase from 25 percent in 1983-85 to 31 percent in 2000.

With a higher proportion of processed products in total horticultural exports, their unit value would increase, with a consequential increase in earnings to US$13-17 billion, about 6-8 percent higher than earlier estimates.

Projections of Net Exports

The foregoing projections of developing-country exports are given in gross exports. The net trade of developing countries will be less. Since world trade is assumed to be balanced, net exports of developing countries are equal to net imports of developed countries. Net exports of developing countries are given in Table 30.

Net exports of developing countries in 1984 were about 11.8 million tons, 10.6 million tons of fruits and 1.2 million tons of vegetables. Thus, in the scenario based on a constant share of imports in aggregate demand, little change is projected in net trade, even though both gross imports and exports are projected to expand significantly. Surprisingly, under this assumption, developing countries will change to net importers of vegetables in the year 2000. However, if the share of imports in aggregate demand increases, developing countries will remain net exporters of vegetables, and their net export of fruits will increase by more than 28 percent over the base year by 2000.

Imbalance Between World Imports and World Exports: Future Price Trends

A question may, however, be raised concerning the underlying assumption that world exports will expand to match the increase in world imports, so that no change will take place in prices in the future. An independent projection of exports may not end up with the same quantity of imports, and this may require a change in prices to bring world supply and demand into balance (Table 31).

If exports grow at trend rates through 2000, the growth rates projected for the world horticultural exports—fruits, 2.04 percent; vegetables, 3.91 percent; and total fruits and vegetables, 2.75 percent—will be less than the growth rates projected for imports on the basis of growth in income and population and a rise in the import ratio.

The nominal unit values of horticultural exports for the world as a whole and for developing countries enjoyed an upward trend during the period 1965-80, and then began to decline. These trends also hold true when fruits and vegetables are looked at separately (Figure 3). Whether the period 1965-85 is taken as a whole or is split into two subperiods, 1965-75 and 1975-85, the nominal unit values of both fruits and vegetables exhibited a rising trend over the whole period, though the rate of increase slowed during the second period.

Table 30—Projected net exports of horticultural projects of developing countries in the year 2000

Commodity	Scenario I		Scenario II	
	Net Exports	Growth Rate	Net Exports	Growth Rate
	(1,000 metric tons)	(percent)	(1,000 metric tons)	(percent)
Fruits	12,061	0.80	15,504	2.39
Vegetables	−1,439	. . .	1,097	1.86
Vegetables, excluding potatoes	175	−11.60	903	−2.00
Total fruits and vegetables	10,622	−0.46	16,601	2.35

Source: Calculated from data in Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome, 1988.

Notes: In Scenario I, a constant ratio of imports to demand in 1984 is used for projections. In Scenario II, trend functions are estimated to obtain the projected ratio of imports to aggregate demand in the year 2000.

As far as real unit values are concerned, there was no strong trend in the real price of either fruits or vegetables in the aggregate for the period as a whole (Figure 4). However, in examining the most recent period, 1975-85, a downward trend in the real price of vegetables is discernible—an indication of a high rate of growth of supply in relation to the rate of growth of demand. Data indicate no trend at all for fresh or processed vegetables or for processed fruits. Only for fresh fruits was there a slight downward trend.

At the same time, it should be noted that horticultural products fared better over the long haul than the other main groups of food and agricultural products. There were significant downward trends in the real prices of cereals, fats and oils, and agricultural raw materials during the period 1961-85. There was no significant trend in the real price of beverages. However, during the latter decade, 1975-85, with the exception of the downward trend in cereals, there were no significant trends in the real prices of other commodities.

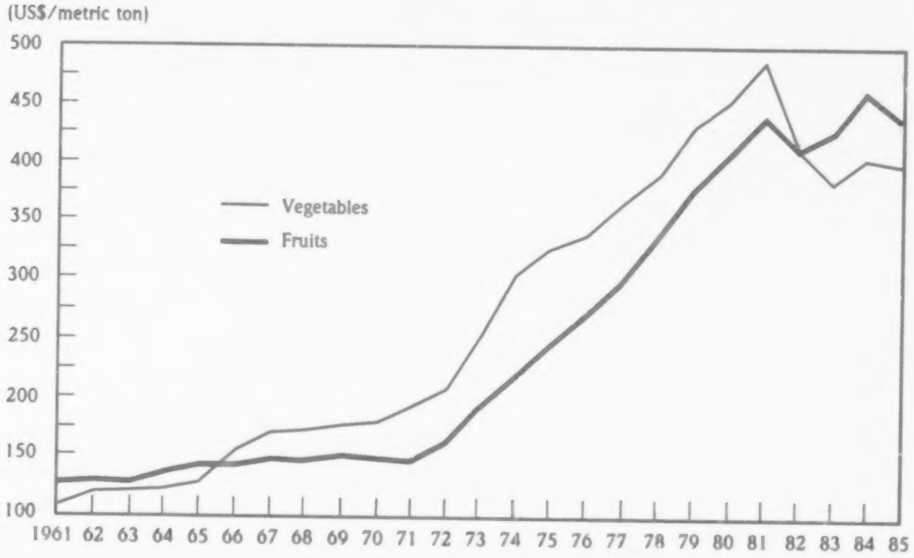
The 1975-85 downward trend in the real unit value of vegetable exports occurred during a period when there was substantial acceleration in the rate of growth of exports, not only compared with earlier years but also with fruits. Competition in world trade of vegetable products was intense, leading to fluctuations in the shares of the individual

Table 31—Imbalance between projected world imports and exports of horticultural products

Commodity	Import Projection		Export Projection	
	Quantity	Growth Rate	Quantity	Growth Rate
	(1,000 metric tons)	(percent)	(1,000 metric tons)	(percent)
Fruits	50,976	3.09	42,792	2.04
Vegetables	44,507	3.93	42,968	3.91
Vegetables, excluding potatoes	34,568	3.96	35,355	4.36
Total fruits and vegetables	95,483	3.36	85,760	2.75

Source: Calculated from data in Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome, 1988.

Figure 3—Unit prices of developing-country fruit and vegetable exports, 1961-85



Source: Based on data compiled by the author from various FAO sources.

exporters. A few countries lost shares and others gained. Cost-reducing innovations may also have contributed to this phenomenon.

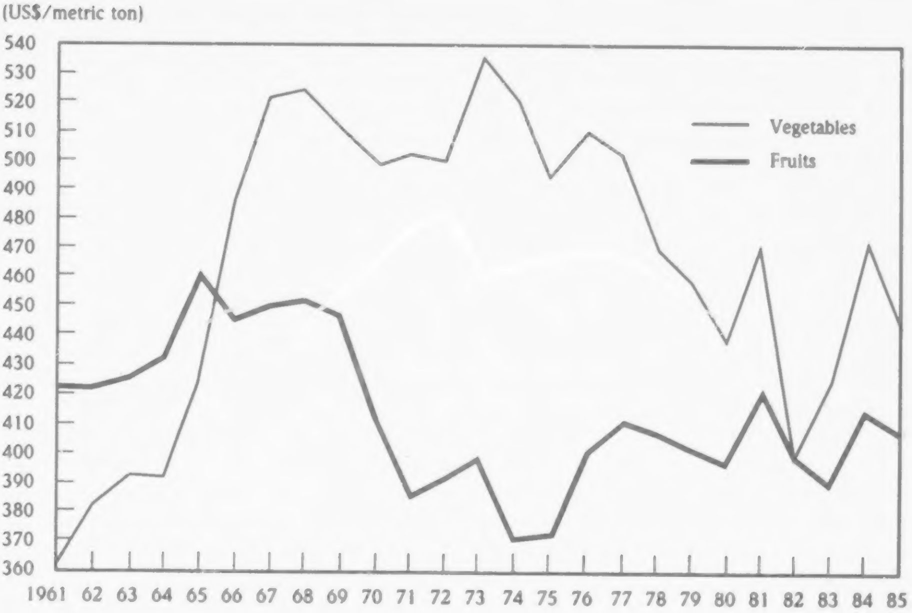
What are the prospects for price developments in horticultural exports? As indicated above, import demand is projected to exceed export supply by 2000, with the result that there is likely to be upward pressure on export prices, especially for fruits. A balance between supply and demand will require either an increase in supply or a reduction in demand.

Sources of Future Growth

Of the two factors that have driven the expansion of horticultural exports from developing countries in the past—the increase in world import demand and the increase in the developing countries' share of world exports—it was the increase in world import demand that was the predominant engine of growth. This was due more to a rise in the share of imports in aggregate demand than to an increase in aggregate demand as such. In fact, if the share of imports in total consumption continues to rise at the trend rate, as is projected, the share of imports in aggregate demand will increase from 18 to 23 percent for fruits and from 4 to 7 percent for vegetables.

If the share of imports in aggregate consumption is unchanged, the volume of exports is projected to go up by about 33 percent, from US$9 billion to US$12 billion. If the share of imports continues to grow at the past rate until 2000, exports are expected to increase by about 70 percent, reaching US$15 billion.

Figure 4—Real prices of developing-country fruit and vegetable exports, 1961-85



Source: Based on data compiled by the author from various FAO sources; and World Bank, *Commodity Trade and Price Trends* (Washington, D.C.: World Bank, 1988).
Note: Export unit values are deflated by the manufacturing unit value c.i.f. index.

What is likely to be the main driving force behind the expansion of exports in the future? It is unlikely that aggregate demand in developed countries is going to grow fast. The major source of growth in aggregate demand will be in the developing countries and in the centrally planned economies. But import demand in developing countries will rise only as the result of a substantial acceleration in their overall economic growth, combined with liberalization of their import trade. Even then, the share of the total world import demand held by developing countries will be quite low. In view of the large domestic market, the expansion of import trade in developed countries and in the centrally planned economies holds the key to the future expansion of exports from developing countries, at least in the medium term.

At the same time, the developing countries must strive to increase their share in world horticultural trade. In fact, a greater emphasis than in the past needs to be placed on this source of growth. In strengthening the competitive advantage of developing countries in world horticultural trade, the development of infrastructure and cost-reducing technological innovations play an important role. In the drive to increase their share of the world market, the developing countries should emphasize the intradeveloping-country trade and markets in the centrally planned economies, as well as developed-country markets.

It may be recalled that the earlier estimate of the increase in exports of developing countries was based upon an increase in income of about 5 percent a year and an unchanging share of developing countries in world trade (Table 32). If the world economy recovered quickly and the rate of growth of developing countries increased to 7 percent, the increase in their exports would still be no more than US$1 billion annually, largely because their share in total world imports and consequently the absolute volume of imports, remain low. It is arguable that in the years to come, developing countries can increase their share of world trade, at least by increasing trade among themselves. The developing countries now obtain about 51 percent of their imports from other developing countries. If an increase to 70 percent is assumed, developing countries would supply an increasing share of the total imports of developing countries; their exports would increase by about US$7-9 million annually.

As for the developed countries, the slow growth of import demand in the centrally planned Eastern European countries in the past contrasts markedly with the rest of the world. The rate of growth in aggregate demand in Eastern Europe was even higher than that in Western Europe. But the high growth rate in domestic demand was met by a corresponding increase in domestic production, so that import demand continued to stagnate. For example, between 1970-72 and 1983-85, aggregate demand increased by 45 percent, but imports did not increase at all, resulting in a fall in the import demand ratio.

A high rate of growth in aggregate demand is likely in the future because current per capita consumption is low (Table 33). Per capita consumption of vegetables in the centrally planned economies is higher than that in most developed market economies. However, per capita consumption of fruits is markedly lower. Fruit consumption in the U.S.S.R. is even less than in the rest of Eastern Europe. Insofar as fruits other than bananas and citrus fruits are concerned, per capita consumption in the U.S.S.R. and Eastern Europe is still lower than that of Western Europe or North America; however, it is higher than that of Japan. The most significant differences between the U.S.S.R. and Eastern Europe, on the one hand, and the developed market economies, on the other, lies in consumption of bananas and citrus fruits. Per capita consumption of these two categories of fruits is only 11 and 14 percent, respectively, of the per capita consumption in the developed market economy countries. Eastern Europe, including the U.S.S.R., has severely restricted import demand for noncompeting products like bananas and citrus fruits, which are not domestically produced. If per capita consumption is allowed to increase by 2 kilograms per capita, this alone would create an additional import demand of about 1.6 million tons, which is about 39 percent of horticultural imports during 1983-85.

Table 32—Value of developing-country exports projected to the year 2000 under different assumptions

Share of Intra-Developing-Country Imports in Total Imports	Annual Income Growth Rate			
	4.9 Percent		7.0 Percent	
	Scenario I	Scenario II	Scenario I	Scenario II
	(US$ billion)			
51 percent	11.7	15.4	12.7	16.4
70 percent	12.4	16.3	13.4	17.3

Source: Calculated from data in Food and Agriculture Organization of the United Nations, "Agriculture: Toward 2000 Data Tape," Rome, 1988.

Notes: In Scenario I, a constant ratio of imports to demand in 1984 is used for projections. In Scenario II, trend functions are estimated to obtain the projected ratio of imports to aggregate demand in the year 2000.

Table 33—Per capita consumption of fruits and vegetables in developed countries, 1983-85

	Fruits					Vegetables			
Country/Region	Total	Oranges	Other Citrus Fruits	Bananas	Other Fruits	Total	Total Minus Potatoes	Potatoes	Pulses
	(kilograms/capita/year)								
North America	123.4	48.8	6.8	10.1	57.7	169.8	108.5	61.3	2.6
United States	151.4	76.2	9.0	9.8	56.4	163.2	109.7	53.5	2.5
Canada	95.3	21.4	4.6	10.5	58.8	176.1	107.1	69.0	2.6
Western Europe	101.6	19.1	4.0	6.5	72.0	181.1	101.8	79.3	2.5
Federal Republic of Germany	116.3	13.5	3.8	7.5	91.5	148.4	74.3	74.1	1.1
France	79.4	16.3	4.4	7.6	51.1	192.3	117.3	75.0	1.9
Italy	131.1	30.3	9.6	4.9	86.3	220.6	178.7	41.9	3.7
United Kingdom	56.0	10.0	2.8	5.4	37.8	180.2	79.2	101.0	3.0
Sweden	76.1	15.9	2.1	8.3	49.8	123.3	52.5	70.8	0.4
Switzerland	139.8	15.5	5.3	8.7	110.3	130.7	82.8	47.9	1.6
Japan	63.2	21.3	4.7	4.6	32.6	140.9	113.9	27.0	2.4
Oceania	83.6	17.7	3.2	6.1	56.6	134.1	80.3	53.8	1.7
Eastern Europe	64.3	3.0	2.5	1.0	57.8	187.6	105.0	82.6	2.9
U.S.S.R.	45.2	2.5	0.8	0.5	41.4	213.6	104.7	108.9	2.8

Source: Food and Agriculture Organization of the United Nations, "Food Balance Sheets," Rome, various years, computer printout.

If the future rates of growth in income and population in Eastern Europe and the U.S.S.R. are as indicated in Table 25, the rate of growth in demand for fruits is projected to be much higher—about 2.8 percent—than that for vegetables—1.8 percent. To what extent this will lead to an increase in imports will depend upon the import policy of this region, that is, whether growth in demand will be met by increased domestic production of the kinds of fruits and vegetables demanded, or whether the consumption pattern will be allowed to diversify through an increase in noncompeting imports, such as bananas, citrus fruits, and other tropical fruits and vegetables.

7

SOME POLICY ISSUES AND QUESTIONS FOR FUTURE RESEARCH

The foregoing analysis of the past trends and salient characteristics of horticultural exports of developing countries, including growth, composition, and geographical destination, was primarily based on aggregate data—historical time series and cross-section data. The results of this analysis raise a number of issues and questions that require more detailed examination of the experiences of individual countries. It is hoped that this will throw further light on past experiences and also help formulate an appropriate strategy for production and export marketing of horticultural products in developing countries.

The issues that require further examination relate not only to the production, domestic marketing, and distribution systems, but also to the organization of and techniques for export marketing, including the provision of export market intelligence, credit, and appropriate shipping and transportation facilities. The basic thrust of this examination is to explore whether the labor-abundant and increasingly land-scarce developing countries already have or can develop comparative advantage in the production and export of horticultural products, and if so, to what extent. Past experience indicates that many developing countries have done well promoting horticultural exports, but others with similar or comparable resource endowments have not done so well.

A number of questions seem relevant in this context. How labor-intensive are horticultural products? Is there a wide variation among horticultural products in labor intensity? Are they particularly suitable or appropriate for small farmers? Are there economies of scale that require large-scale production of horticultural products for export? Again, in countries that have successfully increased horticultural exports, do larger farmers tend to dominate export production? Is horticultural production a way of diversifying or expanding the sources of farmers' output and income?

Increases in horticultural production and exports are often the result of a search for agricultural diversification in response to rising costs of and diminishing returns from the production of traditional crops, partly because a plateau has already been reached in the growth of productivity and partly because the growth of demand has slowed. Does a successful export performance require that producers specialize in the production of horticultural crops? Or do producers who undertake a system of mixed farming—who produce other crops in combination with horticultural crops—do as well? How far is an increase in horticultural production initiated or stimulated exclusively by export demand? In the past, cultivation of many of the traditional export crops, such as cotton, sugar, tobacco, coffee, and tea, was often undertaken predominantly in response to import demand in industrial countries. Does export-led growth of the horticultural sector run the risk of an uncertain future because it is linked to the volatile export market? In countries that have done well in horticultural exports, does a large domestic market for such crops contribute to their success?

Even if the production of horticultural crops is labor-intensive and efficiently produced by small farmers, are there significant economies of scale in their distribution, marketing, and processing? Similarly, while the production of horticultural crops themselves may be labor-intensive, does their marketing and distribution (including handling, transportation, grading, standardization, and quality control) require considerable skill, capital, and organization? How important are good communication and transportation links to the rest of the world in establishing close and constant contact between exporters and importers in view of the perishability of the product, the volatile nature of the market, and frequent changes in consumers' taste?

Labor Intensity of Horticultural Products

There is some evidence in both developed and developing countries that horticultural products are generally labor-intensive. For example, in California, United States, labor intensity in labor hours per acre varies from 1,300 hours for strawberries, 420 hours for tomatoes, 40 hours for walnuts, and 12 hours for sorghum, corn, and rice to 5 hours for wheat and barley. In Kenya, labor intensity for vegetables is 3 times higher than that for maize and 10 times higher than that for wheat, although it is not much higher than that for tea and coffee. In Guatemala, vegetables are about 3 times more labor-intensive than maize or barley.[35] The degree of labor intensity varies among individual fruits and vegetables and from country to country. The differences in labor intensity of the same crop in different countries—tomatoes, for example—in labor input per hectare and the quantity of tomatoes produced is shown in Table 34.

Similarly, the ratio of labor costs to production costs varies among countries for the same commodities (Table 35). In three countries—Jamaica, Mexico, and the United States—and for both cucumbers and peppers, the share of labor in total production costs is high. For cucumbers, shares of labor cost in production cost are the same in Florida and Mexico, but both labor and production costs are much higher in the United States than in Mexico. The ranking of the countries in labor costs seems to determine their ranking in total production costs as well.

In several instances, production techniques also have been adjusted to the relative availability or scarcity of different factors in various countries. For example, in developed countries, attempts are made to use capital-intensive technologies to offset the scarcity and high costs of labor.

The introduction of mechanical harvesting of vegetables is a case in point. Mechanical tomato harvesting, for example, has reduced the advantages of countries or regions with low labor costs.[36] Fruits are less amenable to mechanical harvesting and more suitable for labor-intensive harvesting methods such as picking. On the whole, attempts at mechanization have not been very successful for fruits and vegetables. Even at the high wage rates prevailing in developed countries, it is frequently unprofitable to replace labor with machines in many operations.

Breakthroughs in the mechanization of horticultural production have occurred in operations such as weed control and transplanting, as well as harvesting, but they are

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[35] See Moulton et al. 1986 for U.S. figures, Jaffee 1986 for Kenyan, and von Braun, Hotchkiss, and Immink 1989 for Guatemalan.

[36] The mechanical tomato harvester requires large, uniform tomatoes, which led to the breeding of "hard" tomatoes for the harvester. It increased the advantage of large-scale irrigated farms over small, rainfed farms. Biological innovations in tomato breeding, which were associated with the introduction of mechanical harvesting in California, produced tomatoes with characteristics suitable for growing in countries with inadequate infrastructure, soils, or climate, such as very hot climates. The hard tomatoes could be transported over long distances on rough roads and loaded on trucks without breaking or spoiling. Technical innovations thus reduce the built-in agroecological advantages of specific countries or regions by widening the range of conditions under which a particular horticultural product can be grown (Moulton et al. 1986, 6).

Table 34—Labor inputs and yields per hectare for tomatoes in different countries

Country	Yield per Hectare	Labor Input
	(metric tons)	(hours/hectare/year)
Florida, United States	31	1,000
Mexico	19	2,000
Taiwan	24	8,000
Thailand	16	3,500

Sources: Florida and Mexico data: Katherine C. Buckley et al., *Florida and Mexico Competition for the Winter Fresh Vegetable Market,* Economic Research Service Report 556 (Washington, D.C.: U.S. Department of Agriculture, 1986). Taiwan data: Ruben L. Villareal, *Tomatoes in the Tropics* (Boulder, Colo., U.S.A.: Westview Press, 1980), pp. 4 and 23. Thailand data: Merle R. Menegay, "Improving the Performance of Procurement Systems for Fruit and Vegetable Processors in Thailand: A Case Study of Up-Country Pickers and Canneries," Ph.D. dissertation, Michigan State University, Ann Arbor, Mich., U.S.A., 1985, p. 329.

limited to a few crops. The processes that have been mechanized are relatively simple ones. Crops such as berries have proved difficult, leading to caution in predicting the success of mechanization in the future.

Several factors discourage mechanization. First, it has an adverse effect on quality. Mechanical pickers often bruise products, losing a substantial part of the harvest. At the wages prevailing in the United States, for example, the value of lost fruit is more than the cost of labor engaged to avoid the loss. Second, mechanical pickers cannot pick fruit selectively based on maturity; they make a single harvesting pass through the field. A successful harvester for fresh strawberries, for example, is unlikely, because fruit matures unevenly and the plants are very delicate. The same is true for lettuce, citrus fruits, and melons (Daines and Hargreaves 1985, 15-19).

The disadvantage of high labor cost in developed countries can be offset by the development of higher-yielding varieties (HYVs) through technological research, so that low labor cost no longer provides a competitive edge. This has been the case with strawberries in Mexico, where small farmers grow a low-yielding variety. Over time, California considerably increased its output per hectare through the development of an HYV, a more appropriate rotation of land, and better control of pests and diseases, thus

Table 35—Comparative production costs of cucumbers and peppers in Florida, Jamaica, and Mexico, 1983-85

Cost	Cucumbers			Peppers		
	Florida, United States	Jamaica	Mexico	Florida, United States	Jamaica	Mexico
Total production cost per bushel (US$)	8.56	6.35	3.92	6.29	5.55	4.06
Labor cost per bushel (US$)	4.05	2.74	1.86	2.65	2.37	1.38
Ratio of labor cost to production cost (percent)	47	43	47	42	43	34

Source: Mark A. Peters, "An Analysis of the Economic Potential for Export Vegetable Production in Jamaica," M. S. thesis, University of Florida, Gainesville, Fla., U.S.A., 1987, pp. 89-91.

offsetting the disadvantage of high labor costs. Broccoli, however, is produced in Mexico under contract with U.S. firms that operate freezing plants located in Mexico: Mexican growers benefit from U.S. technological innovations and varietal improvements (Moulton and Runsten 1986). Thus, yields are comparable in Mexico and the United States, but low labor costs confer on Mexico a comparative advantage, not only in the production of broccoli (Mexican wage cost being one-third of the U.S. wage cost) but also in the freezing industry (Mexican wages being less than one-tenth of American wages). The low labor cost is especially advantageous for Mexico because transplanting techniques for broccoli are highly labor-intensive, and the United States has not succeeded in devising a mechanical technique for transplanting.

Horticultural products usually require more working capital than other crops because they use more current inputs like fertilizer and pesticides. In Guatemala, for example, the input costs per hectare are 13 times higher for snow peas than for maize (von Braun, Hotchkiss, and Immink 1989). Furthermore, input costs relative to labor costs are much higher for vegetables than for cereals. The value of current inputs relative to wage costs is 300 percent higher for snow peas and 30-50 percent higher for traditional vegetables, broccoli, and cauliflower.

Scale Economies in Horticultural Production

In a few countries, the entry into export markets for horticultural products was based in the initial years on the production of large farms, but eventually production for the export market spread to small farms. In a number of these countries, production of horticultural products for the export market was initiated by foreign settlers—by the British and Asian settlers in Kenya, for example, or the French settlers in Côte d'Ivoire, who happened to be the large farmers. Foreign-owned exporting firms combined production with processing and marketing and found it easier to manage large plantations. Finally, the exporting firms that resorted to contract farming found it easier to deal with a limited number of large farmers than with numerous small farmers scattered over a wide region.

In the course of time, however, production of export crops did spread to small farmers, either because contractors found ways of dealing effectively with small farmers or because the prices at which they could obtain supplies from small farmers were lower, or because the amount of production available from large farmers was inadequate, and additional supplies could only be obtained by extending production to the small farmers.[37] As a result, the bulk of production of fruits and vegetables for the export market in Kenya and Côte d'Ivoire is supplied by small farmers.

That supplies are obtained from small farmers at a lower price than that paid to large farmers is, in some cases, attributed to the weaker bargaining power of small farmers vis-à-vis the processing plants and contractors or the traders. Small farmers are often willing to accept an income for their family labor that is less than the wage cost of hired labor.

Sometimes historical and institutional circumstances confer advantages on small farmers. This has been the case, for example, in Senegal. The region of the country that is agro-ecologically suitable for growing horticultural products has a land tenure system that gives small farmers an advantage. Small farmers who settled in the region a long time ago had usufruct rights to the land. Plots that became available later on for new farmers were not large enough for mechanized and large-scale farming. Also, small farmers water their land using labor-intensive techniques at a lower cost, whereas the large-scale farmers are obliged to use diesel pumping of metered wells (Horton 1987). In Senegal, small farmers produce 60 percent of horticultural exports; medium farmers, owning 1-5 hectares, account for 17 percent, and the rest is produced on large-scale estate farms (Horton 1987, 18).

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[37] The comparative advantage of small farmers in horticultural products in Guatemala was due not only to high labor intensity and low opportunity cost of family labor but also to careful field management and supervision required to meet quality standards (von Braun, Hotchkiss, and Immink 1989, 29).

In Guatemala, the production by small farmers of nontraditional vegetables destined for export marketing in the United States and Western Europe was initiated and stimulated by international development assistance agencies (von Braun, Hotchkiss, and Immink 1989). They provided financial assistance to a private company to open up export channels. At the same time, they helped organize a cooperative of small farmers to grow nontraditional vegetables and to gain access to export outlets through the private company. A foreign private company, a subsidiary of a U.S. company, provided know-how and related infrastructure, such as cold storage. Guatemalan public agencies also provided credit and technical know-how to the farmers' cooperative, including assistance for the development of vegetable processing equipment. The cooperative provided a wide range of services ranging from extension and education at the farm level to the supply of inputs, collection of produce from individual farmers, selection and grading of export products, and storage. Under a contractual arrangement with a foreign export company, it was able to obtain assured access to export markets. Eventually, the cooperative began to export independent of the foreign export company through alternative marketing channels.

Yet scattered evidence from countries such as Kenya and Senegal indicates that not all export commodities are suitable for smallholder contract farming. The need for closer control over or supervision of the production processes in order to ensure the standardized quality and volume required in export markets favors large-scale estate farming. Where exporters control and manage large-scale estate farms, they are often able to introduce new crops and to make improvements faster through ongoing evaluation of the yields of current varieties or cultivation practices. In the initial years, the contract farming system based on small farmers is sometimes cumbersome in introducing innovations. Once the new crops or practices are widely known, contract farming by small farmers is usually profitable. In Kenya, for example, Kenya Canneries, Ltd. (a Del Monte subsidiary) did not find it profitable in the early stages to undertake production of pineapples on the basis of a contract with small farmers; instead, the company decided to grow fresh pineapples on its own estate farms. In Kenya, fruits such as pineapples and avocados are mostly produced by large farmers, whereas vegetables are grown by both large and small farmers (Jaffee 1986).

Large farmers often have two advantages. First, their bargaining position vis-à-vis exporters is strong; they can provide large quantities of uniform batches of products on a continuous basis. Second, they are able to diversify their production, combining horticultural crops with export crops such as coffee or with noncrop activities such as cattle breeding, as is the case in Kenya (Hörmann 1981, 31-52).

In Côte d'Ivoire, the producers' cooperative, COFRUITEL, which is composed of large farmers, dominates the production of horticultural products for export, particularly pineapples and bananas. It not only supervises and coordinates its members' production, but it also assists them in procuring inputs and credit and arranging international transportation and marketing of products, including the provision of phytosanitary services. Whereas the production of fresh pineapples for export is dominated by the large enterprises, the production of pineapples for supply to the domestic processing industry (the output of which is also partly exported) is undertaken by small farmers, organized in various cooperatives of their own (Hörmann and Wietor 1980, 21-28). The large farmers in Côte d'Ivoire have mechanized a number of operations, excluding sowing and planting; for example, they have replaced labor with herbicides and use mounted sprayers for pesticides.

In Kenya, horticultural products are produced on a wide range of farm sizes. First, there are the large-scale estates, averaging 100 acres or more, with large investments in irrigation and heavy use of inputs, hired labor, and skilled management. These large estates often cultivate traditional export crops such as coffee and sisal. Second, there are the medium-size farmers with 10-50 acres who mostly produce fruits, and those with 8-30 acres who mostly produce vegetables. They work predominantly on unirrigated lands. Third, there are the smallholders with access to inputs and water. Those with 6-20 acres may produce other cash crops; those with only 2-5 acres only produce horticultural crops for export. Fourth, there are the small farmers on rainfed land with meager access to inputs and water, who produce horticultural crops and foodcrops exclusively. Out of their total farmland of less than 6 acres, they devote about 1 acre to horticultural products and the rest to subsistence crops; they do not produce other cash crops. The participation of these various farm types in horticultural production for export markets is shown in Table 36.

Insofar as the importance of economies of scale in the cultivation of horticultural crops is concerned, the evidence so far is inadequate and inconclusive. Furthermore, there are differences between horticultural products in this regard. Empirical evidence on yields per hectare or costs per unit of output from farms of different sizes is difficult to come by. In the Philippines, Hayami, Adriano, and Quisumbing (1988) show that yields from plantations and small farms are comparable for both bananas and pineapples. In Kenya, Hörmann (1981) finds that small farmers raising French beans spent 36 percent of production costs on inputs and 64 percent on wages, whereas large farmers spent 54 percent on inputs and 46 percent on wages; their total production costs per hectare were quite similar, however. These examples do not indicate the presence of any significant economies of scale in the production of bananas and pineapples in the Philippines or of French beans in Kenya. And, in Guatemala, gross margins per hectare for individual crops did not vary in any systematic way with variation in the sizes of farms

Table 36—Percentage of export-oriented production in different types of farms, Kenya, 1985

Crop	Large Estates	Medium-Size Farms	Smallholdings	
			Well-Endowed	Not Well-Endowed
Pineapple	100	. . .	. . .	. . .
Strawberry	100	. . .	. . .	. . .
Passion fruit	30	15	35	20
Avocado	20	25	30	25
Asian vegetables	10	35	25	30
Mango	0	35	20	45
Fresh beans	10	40	30	20
Processed beans	0	5	5	90

Source: Steven Jaffee, "The Kenyan Horticultural Export Sector: An Economic and Institutional Analysis of Alternative Marketing Channels," final report to the U.S. Agency for International Development, St. Anthony's College, Oxford University, Oxford, 1987.

(von Braun, Hotchkiss, and Immink 1989, 44). For traditional vegetables and snow peas, the smallest farms—those between 0.25 and 0.50 hectare—had the highest gross margins per hectare, but the next size group (0.50-1.00 hectare) had lower gross margins than the largest farm-size group, those with 1 hectare or more. For broccoli and cauliflower, the farms between 0.50 and 1.00 hectare had the highest gross margins per hectare, while gross margins for the largest farms—1.00 hectare and more—declined slightly.

In another case study in Kenya, Shapiro and Wainana (1987, 18-20) found that the minimum efficient farm size varied from crop to crop. For example, cashew nuts, pineapples, macadamia nuts, and citrus fruits required more land than other horticultural products, implying that on farms that are smaller than the minimum for efficient production, the unit costs of production are higher. The study finds that vegetables are more labor-intensive than fruits and nuts; the labor requirements for vegetables are estimated to be two man-years per hectare as against two-thirds of a man-year for fruits and one-twelfth of a man-year for nuts.

Thus the presence of significant economies of scale in horticultural production seems unlikely, based on evidence so far. A few agricultural operations may yield economies of scale—the control of pests and diseases or the use of tractors for land preparation or irrigation facilities, for instance, but it is possible to devise institutional arrangements that enable small farmers to realize the scale economies of these specific operations.[38] Insofar as marketing, distribution, transportation, and processing of horticultural products are concerned, however, there are economies of scale.[39]

Economies of scale are prevalent in storage and transportation operations. Marketing costs are high for fresh products because they may require refrigerated facilities in transit, at collecting points in the producing regions, and at the point of shipment by sea or air. A substantial fixed investment in such facilities may yield economies of scale. Close coordination of production, processing, and marketing in order to meet the quality requirements of export markets leads to economies of scale; such coordination is more easily accomplished when large quantities are marketed or processed. For example, a boatful of bananas that meet all quality standards must be collected within a few days. The whole chain of activities from production to marketing or distribution needs to be precisely scheduled and controlled. Transaction costs can be reduced by dealing with large shipments and by spreading overhead costs of labeling, packing, and so forth over a large quantity. To secure access to a regular shipping service, countries need to have a sufficient volume of trade to attract shipping lines to call at their ports.

Transportation and Export Marketing of Horticultural Products: Some General Issues

The share of transport and marketing costs in the total cost or sale price of horticultural products is high, as can be seen from the costs of exporting vegetables from

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[38] The incidence of pest outbreaks and contagious diseases increases if the same plant species is grown over a wide area. Hence the uniform specification of strict pest and disease control measures over an entire area is essential for maintaining quality and ensuring adequate output. Cooperative or joint arrangements are therefore needed by small farmers for efficient control and management of pest and diseases.

[39] The marketing and distribution of horticultural products often require skill and organization, including specialized equipment for transporting perishable commodities. Many countries airfreight horticultural products rather than shipping them by sea. In Kenya, passenger airlines passing through Nairobi are obligated to allocate cargo space for Kenyan horticultural products, and concessional freight rates are negotiated by the government with the airlines.

Mexico to the U.S. market (Table 37). These costs, which include production, internal and external marketing, distribution, and transportation costs to the point of entry into the United States (excluding the profit margins of importers, wholesalers, and retailers), averaged about 50 percent; in some extreme cases, they were as high as 70 percent. For airfreighted products from Guatemala to the United States, the international transport and marketing costs constituted a much higher percentage of total costs—42 percent.

International transport costs play an important role in determining the competitiveness of horticultural exports in the world market. The labor cost advantage of the low-income developing countries can be lost if the share of transport costs in the final sale price of products is too high. In Table 38 the horticultural products of El Salvador are ranked by the value of the crop—the transport feasibility index—and the number of labor hours required per ton. The higher the unit value of the product, the greater is its ability to sustain high transport costs because these costs constitute a small share of a high value product. There is no systematic relationship between the two rankings, even though some products that have high labor intensity also happen to have high unit value, and others that have low labor intensity happen to have low value.

It is important to note that the horticultural products that are sold in the domestic market are often different from those sold in the export market. In Kenya, for example, this is true for vegetables more than for fruits. Even though there is a growing domestic market for many exportable fruits, the varieties of fruits that are sold in export markets are usually different, with the result that the marketing channels are also differentiated. In several cases, the horticultural products for export are "demand driven" by foreign importers rather than "supply driven." New crops that are not consumed or produced at home are introduced in order to meet export demand. Several examples are French beans in Kenya; snow peas, cauliflower, and broccoli in Guatemala; and beans, melons, and peppers in Senegal.

The marketing and distribution systems for horticultural exports are highly diverse, conditioned partly by the historical circumstances of different countries. In some cases, farmers are linked with exporters by the traders who collect and distribute their products in the domestic market, as well as to exporters. In other cases, the production,

Table 37—Shares of cost components in total cost of selected Mexican horticultural exports to the United States, 1984/85

Commodity	Production Costs[a]	Internal Transport and Marketing Costs[b]	International Transport and Handling Costs[c]	Total Costs at Point of Delivery
		(percent)		
Tomatoes	48	29	23	100
Bell peppers	42	38	20	100
Cucumbers	30	36	34	100
Green beans	54	28	18	100
Eggplants	38	30	32	100
Squash	49	22	29	100

Source: Katherine C. Buckley et al., *Florida and Mexico Competition for the Winter Fresh Vegetable Market*, Economic Research Service Report 556 (Washington, D.C.: U.S. Department of Agriculture, 1986).

[a] Production costs include harvesting and packaging.

[b] Internal transport costs are from the farm to the export point.

[c] International transport costs are from the export point to the delivery point in the importing country (New York).

Table 38—Ranking of selected horticultural products in El Salvador by transport feasibility

Commodity	Transport Feasibility[a]	Labor Cost Advantage[b]
	(US$/metric ton)	(hours/metric ton)
Strawberries	2,400	113
Mushrooms	2,000	170
Asparagus	1,500	85
Broccoli	1,200	55
Tomatoes	1,000	60
Cucumbers	750	47
Cauliflower	650	40
Citrus fruits	550	28
Bananas	350	32
Pineapple	300	30

Source: S. Daines and G. Hargreaves, "Fruit and Vegetable Export Possibilities for El Salvador," U.S. Agency for International Development, Washington, D.C., 1985, pp. 5-19 (mimeographed).

[a] The index of transport feasibility is the value of a ton of output. The higher the value, the greater the crop's ability to sustain high transport costs.

[b] Labor cost is the number of labor hours spent per month for producing, harvesting, and packaging a ton of produce.

marketing, and processing of horticultural products are integrated through plantation or contract farming systems based on contracts between producers and exporters, on the one hand, and exporters and importers abroad, on the other. Both foreign and domestic enterprises are engaged in either large-scale estate farming or contract farming or both.

In Côte d'Ivoire, producers have formed a cooperative of their own to market export products. Frequently, exporters are few and marketing intermediaries are many in the chain of distribution within a country; the number of traders declines closer to the final stage of exporting. In Kenya, for example, five firms accounted for 60 percent of total fresh horticultural exports, and nine firms accounted for 85-90 percent in 1985. Four of them produce fruits and vegetables on their own estates; others obtain supplies from contract farmers or through their agents or wholesalers (Jaffee 1986, 15-38).

Since adjustments need to be made at relatively short notice due to changes in demand and in product specifications, there is a need for direct and regular contact with importers abroad. There is intense competition in the horticultural trade among a few exporters, often for the production of specialized products for designated markets. Different countries and regions demand specific qualities, sizes, grades, varieties, and types of a particular commodity. Since there is seldom a costless movement from one quality or grade to another, exporters are often obliged to specialize in particular grades and qualities; close and continuous contact with overseas markets becomes all the more essential. Therefore, contractual arrangements with importers abroad reduce marketing risks and help provide efficient market information. The barriers to entry into export marketing arising from limited access to export market information can be relieved by the government itself providing information. A reputation for reliability, as perceived by overseas importers, can only be acquired over time. A final barrier—command over financial resources in order to be able to take risks—warrants more detailed examination of individual country experiences.

The participation of multinational corporations or foreign direct investment facilitates access to export markets. It is not clear from the existing evidence what is the best or the most cost-effective method of organizing distribution and marketing systems in the export market. Is the active participation of multinationals or foreign trading companies with direct and established links to distributing and marketing channels abroad essential to successful export marketing, especially in the early stages? In the case of processed horticultural exports, multinational companies dominated in the early stages in Kenya and a few Latin American countries; in the course of time, domestic processors and traders entered the export market. In Kenya in the early 1980s, the five largest processing companies engaged in export marketing had either foreign ownership or expatriate management. Many exported through their affiliated firms abroad (Jaffee 1987, 15-38). Transnational corporations engaged in the production and processing of fruits and vegetables have been involved in both export and local markets. Thirty-three leading firms operating in horticultural exports in developing countries had more than 140 investments in developing countries. In export-oriented activities, the most important operations were in bananas, canned tropical fruits, and fresh produce. In domestic market-oriented activities, the main operations were in canning and dried products (United Nations Centre on Transnational Corporations 1981).

However, the operations of transnational corporations are not widely distributed among a large number of countries in all regions, but tend to be concentrated in a few countries. Latin America has been the largest recipient of investment from transnational corporations in horticultural products. There were 60 operations by various U.S. companies, 29 by European, and 1 by Japanese in the late 1970s, whereas the Pacific and East Asian region had only 14 operations by U.S. companies, 12 by European, and 2 by Japanese. Africa and West Asia had 6 operations by U.S. companies, 24 by European, and 1 by Japanese. Although capital and technological requirements for many of these activities are not significant, the transnational corporations are often the market leaders, with organized export outlets, primarily because of their high degree of efficiency in marketing and promotional activities.

The circumstances under which the processing of horticultural exports shifts from developed to developing countries also needs further analysis. The share of processed products in total horticultural exports of developing countries is on the increase and is expected to rise in the future. Also, in view of the increase in domestic demand in many high-income developing countries, opportunities for a domestic processing industry in these countries are likely to expand in the future. The developed importing countries have a choice between importing fresh products for processing at home or transferring the processing facilities to the developing exporting countries and importing the processed products. The establishment of processing facilities in developing exporting countries rather than in developed importing countries depends among other things on labor costs in relation to the costs of transportation of fresh products from developing countries. Importing fresh products for the purpose of processing them in developed countries is not only expensive because the cost of transportation constitutes a high percentage of the total cost of raw materials, but it also often runs the risk of loss of freshness or deterioration in quality.

Moreover, a shift of processing facilities to developing countries also serves the expanding domestic markets in those countries. The feasibility of processing in developing countries also depends on the level and intensity of tariff and trade restrictions on processed products in the importing countries. Similarly, the extent to which the establishment of processing facilities is encouraged in the developing exporting countries depends on the trade restrictions in developed countries. Both developed and developing countries have tariff structures that escalate with the degree of processing.

Research and Development and Supportive Policies for Exports

Success in export markets requires efficient research, education, and extension services in developing countries. What is needed is an effective link between export markets, on the one hand, and domestic research and extension services, on the other, through the medium of marketing agencies and public or private institutions engaged in the dissemination of export market intelligence. Such a link would facilitate the systematic transmission to farmers of information about the requirements of export markets regarding the desired characteristics and quality of export products.

Research and extension services for horticultural products are often inadequate. There is a wide variety of products, each with a small aggregate value of output or export. At the same time, a critical minimum effort is needed to develop a viable technological package for any crop, however small in value. Therefore, the requirements for technically trained manpower for research, including associated infrastructure, are likely to be large in relation to the value of horticultural output. This suggests the need for careful selection of the products on which research efforts should be concentrated.

Considering that, over time, comparative advantage may shift among countries and that there is intensive competition in the export market, exporters need to be flexible in shifting research expenditures between crops to meet changing market conditions. Associated with the need for adequate research expenditures is the need for production and distribution of an adequate quantity of high-yielding seeds to individual farms, which are small in size but large in number and scattered over long distances.

Table 39 indicates the ratio of horticultural scientists to total crop scientists in selected developing countries relative to the importance of horticultural exports in total agricultural exports. Countries vary widely in their relative emphasis on horticultural research, and the share of horticultural scientists is not correlated with the relative importance of horticultural exports.

It should be noted, however, that the relative number of horticultural scientists among crop scientists is not an accurate indicator of the size and quality of a research effort; the amount of research expenditure and an index of the quality of the researchers are probably better indicators, but this information is seldom available. The lack of a positive relationship between the importance of horticultural exports and of scientists engaged in research on them is probably due to the fact that in most countries the allocation of research expenditures among crops is governed by the domestic output and demand for horticultural products rather than by exports. To increase the allocation of research expenditures to crops such as horticultural crops, which have relatively low priority because of their small share in total agricultural output, would probably require a large increase in total agricultural research expenditures (Schluter 1984, 106-107).

Institutional arrangements for the organization of research and extension services, especially regarding the relative roles of public and private sectors, are different in various countries. Government policy regarding research, infrastructure, education, and training is important. For quality control, grading, standardization, and the control of pests and diseases, the public sector has an important responsibility. In view of the close competition in the export markets for horticultural products, a continuous effort to upgrade quality and to improve disease and pest control measures is crucial. In research, not only the government but also private companies, mostly foreign, must play an important role. Where multinationals or their subsidiaries either participate in production or obtain supplies through contract farmers, they frequently undertake technological research and provide related education and extension services. In Kenya,

Table 39—Share of horticultural scientists in total crop scientists and of horticultural exports in total agricultural exports, selected developing countries, 1983-85

Country/Region	Horticultural Scientists/ Total Crop Scientists	Horticultural Scientists/ Total Crop Scientists, Excluding Root Scientists	Horticultural Exports/Total Agricultural Exports
		(percent)	
Country			
Brazil	13.86	8.17	12
Turkey	47.07	40.96	40
Taiwan	8.10	7.07	n.a.
Mexico	31.75	18.37	31
Philippines	38.69	15.34	26
Chile	18.22	2.54	36
Thailand	11.76	10.42	8
Morocco	36.54	30.13	90
Argentina	25.38	18.04	5
Honduras	45.96	26.09	49
Costa Rica	46.36	13.64	39
India	20.82	2.89	10
Colombia	20.10	13.24	8
Egypt	54.76	44.80	23
Ecuador	48.18	23.36	31
Korea	18.69	18.69	23
Cyprus	21.74	21.74	60
Guatemala	68.52	17.59	15
Côte d'Ivoire	31.54	20.13	5
Panama	28.89	0.00	53
Malaysia	12.49	10.75	2
Kenya	33.33	18.75	11
Jordan	67.05	59.09	51
Iran	28.57	20.17	64
Region			
Asia	19.85	7.48	9
Latin America	32.30	14.35	12
North Africa/ West Asia	45.53	36.90	35
Sub-Saharan Africa	22.35	10.74	7

Source: Basic data compiled by Peter Oram, International Food Policy Research Institute.
Notes: Countries are given in the order of their world market share in 1983-85. Linear correlation between the share of horticultural scientists and the share of horticultural exports was not significant at the 95 percent level.

the Horticultural Crops Development Authority, a government agency, promotes research through government research institutes.[40] In Côte d'Ivoire, the Government Horticultural Research Institute, 50 percent of which is financed by French Technical Assistance, is responsible for research (Hörmann and Wietor 1980, 5-19). Moreover, in Côte d'Ivoire, the government established a separate agency (SUDEFEZ) for undertaking education, extension, and training of horticultural farmers.

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[40] The Horticultural Crops Development Authority has, among others, the following functions: (1) promotion of production and marketing of horticultural products through education, extension, and training of farmers; (2) supervision of export products for quality control and packaging; (3) granting of export licenses to exporters; (4) standardization of containers; (5) preshipment inspection at export points for enforcing quality standards; (6) allocation of scarce cargo space among the experts; and (7) provision of market information in cooperation with the International Trade Center in Geneva (Shapiro and Wainana 1987, 8-11).

Furthermore, government may also play a role in providing trade information to importers abroad about sources of supply in exporting countries and to domestic exporters about foreign markets. In some countries, for example, the government agencies undertake an independent analysis of export markets, including competitors' prices and availability of supplies. They also promote or arrange for the participation of exporters in foreign trade missions, fairs, and exhibitions.

Successful export-oriented countries, such as Hong Kong, Korea, Singapore, and Taiwan, have demonstrated that, within the framework of efficient macroeconomic and sector-specific policies, trade promotion measures such as information services; effective participation in trade fairs and missions; external publicity, market analysis, and development; and assistance to export firms in product design, packaging, and marketing are important (Keesing 1988, 2).

Success in production and marketing of horticultural products in world markets also depends on economy-wide exchange rate and trade policies. Policies regarding the import of inputs—both intermediate inputs and capital equipment for processing operations—are often important: liberal access to imported inputs is more often than not a key component of export-oriented trade policy (Keesing 1988, 5).

Although the foregoing analysis touches on a number of issues that are important for the future growth of horticultural exports from developing countries, the evidence presented, based on secondary data, is incomplete. More detailed country-specific empirical investigations are needed to provide a more informed basis for the formulation of an appropriate strategy for this sector.

8

CONCLUSIONS

Horticultural products are growing in importance in world agricultural trade and in developing countries' agricultural exports. Developing countries have increased their share of world horticultural trade over the years, with fruits constituting a large proportion of their total horticultural exports. Although the nominal unit value of horticultural exports has increased over time, the real value has not shown an upward trend. Trade in individual commodities has been concentrated in a few exporting countries; the top four exporters accounted for 80-100 percent of total exports in many commodities. The European Community, the United States, and Japan have been the most important markets for these exports, with imports growing fastest in recent years in the United States and Japan.

Most of the horticultural trade, however, is carried on between the developed countries themselves, acting as both exporters and importers. Tropical horticultural products are the exception. Most horticultural products in developing countries are produced on small farms and in labor-intensive ways, though there is wide variation among crops and countries. With appropriate policies and technology, horticultural production could significantly supplement the income of small farmers and provide additional employment in labor-abundant developing countries. Also, given the urgent need for increased export earnings and the not-too-bright prospects for traditional agricultural exports, the horticultural sector could be an important source of additional foreign exchange. Horticultural products are expected to have better prospects because import demand is growing in the higher-income developing countries, as well as in the developed countries.

Although the domestic market generally dominates the demand for horticultural products, the export market's share is rising for many products, thus providing an additional source of future growth. At the same time, a large domestic market in developing countries, resulting from overall growth in income and high income elasticities of demand, provides a cushion to offset volatility and a springboard for entry into the export market.

But the main source of growth in export markets undoubtedly lies in the developed-country markets, assuming that the ratio of imports to domestic demand continues to rise in response to the diversification of consumption. Improved transportation and communication facilities reduce prices and also widen the range of internationally traded horticultural products. Acceleration of income growth rates in developing countries and liberalization of consumption and import trade in centrally planned economies also could provide growing markets.

Developing countries face intense competition in export markets, except in tropical products, which, however, constitute a rather small proportion of world horticultural trade. Except in "off season" markets, developed countries are both producers and exporters of temperate-zone products.

In order to capture an increasing share of world export markets, developing countries need to strengthen their competitive position by reducing costs and improving quality through extension services and training at the farmer's level. Different horticultural products require different intensities of labor and input use in the same country, but the amount of inputs required for the same product may vary among countries. The comparative cost advantages in particular commodities change across countries and over time as a result of research and development efforts. For example, the steady stream of biological and mechanical innovations in developed countries in many instances offset the advantage of lower labor costs in developing countries.

This emphasizes the need for technological research in the horticultural sector, which to date is underdeveloped. But, in view of the scarcity of available resources and the wide variety of products involved, on the one hand, and the need for a critical mass of research effort, on the other, to develop a feasible technological package for an individual commodity, the choice of products in which a country will specialize assumes great importance. Cooperation among developing countries in research and development efforts could also conserve resources and provide economies of scale.

Since about 70 percent of the final consumer price is accounted for by the cost of processing, distributing, marketing, and transporting the product, the comparative cost advantage, in many instances, depends more on how efficiently and effectively these services are organized than on the actual cost of cultivation.

Farms varying widely in size and in methods of organization in different countries have engaged successfully in export trade. Economies of scale seem to relate more to postharvest activities than to production. How to integrate small farmers into a system of efficiently organized postharvest activities that yield economies of scale and how to promote the appropriate institutional arrangements for this purpose are questions that pose a considerable challenge for developing countries.

The alternative institutional or organizational systems range from farmers' cooperatives to "contract" farming by small farmers for exporters or foreign importers or processing firms. Multinational enterprises often combine production and processing activities with marketing outlets in the importing countries.

The availability of market intelligence and information on world horticultural trade is still rather undeveloped, compared with what is available for other agricultural commodities such as raw materials or tropical beverages. Also, the ability to respond to export market opportunities and to adjust to changes therein requires close, intensive contact with the marketing and distribution systems in importing countries.

An enhanced capacity on the part of developing countries to provide an adequate volume of exports of high and uniform quality is only part of the answer: a reduction of trade barriers in the principal markets abroad must supplement these efforts. Processed products with high value added provide more employment and income than fresh products, but because the degree of restrictions escalates with the degree of processing, they also face higher restrictions in developed-country markets.

The future of trade liberalization in horticultural products is linked with the success of the ongoing GATT negotiations on agriculture. Even though tropical horticultural products are slated to receive early and favorable treatment, they constitute a very small share of the world horticultural trade. Most developing-country exports are in commodities that compete with those of developed countries. During the current round of GATT negotiations, developing countries, especially the high-income developing countries, will be called upon to make reciprocal concessions, though not to the same extent as the developed countries. This should open up markets in the high-income developing countries for the rest.

In the future, the generalized system of preferences (GSP) is likely to be limited to the least-developed countries, whose participation in world horticultural trade is in any case very small. In the past, the GSP scheme not only had limited coverage but also was highly unstable, and it failed to provide assured markets, even for countries on a most-favored-nation basis. If substantial concessions are made on horticultural products, particularly on processed products, exports of developing countries will probably be stimulated, especially if the developed countries make the fastest and most substantial concessions on the labor-intensive commodities in which the developing countries are likely to enjoy comparative advantage.

Furthermore, an international agreement to harmonize phytosanitary and sanitary measures, under the auspices of the GATT, and an effective mechanism for international surveillance to preclude trade-distorting effects would confer substantial benefits on exporting developing countries, especially if these measures are combined with international assistance to improve the scientific and technical capacity of developing countries to implement and monitor them.

Given the same external economic and trade environment and similar agroecological endowments, why have some countries successfully exported horticultural exports and others failed to do so? This question raises a number of others about the appropriate technology, organization, institutions, and policy framework required to improve production and marketing.

This study has touched on only a few issues in a preliminary way and on the basis of scattered and limited evidence. It is necessary to follow up with detailed country studies bearing on these issues, which will be helpful in devising an appropriate strategy for expanding the horticultural sectors of developing countries.

APPENDIX 1: SUPPLEMENTARY TABLES

Table 40—Three-year average export values of fruits, by commodity, and share of developing countries in world trade, 1961-85

Commodity	1961-63			1970-72			1975-77			1983-85		
	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share
	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)
Fresh fruits	1,565,290	694,965	44	2,833,285	1,218,350	43	54,778,681	2,146,690	39	8,424,558	3,658,417	43
Bananas and plantains	323,122	302,245	94	550,546	513,631	93	879,110	819,236	93	1,451,592	1,356,443	93
Bananas	321,658	300,781	94	546,155	509,240	93	874,477	814,603	93	1,436,067	1,340,918	93
Plantains	1,464	1,464	100	4,391	4,391	100	4,633	4,633	100	15,524	15,524	100
Citrus fruits	480,817	143,540	30	839,199	293,321	29	1,619,092	444,684	27	2,337,374	736,272	31
Oranges	343,204	104,927	31	499,381	163,577	33	910,372	291,497	32	1,237,046	447,287	36
Tangerines and mandarins	39,532	25,250	64	110,024	41,673	38	276,471	81,246	29	441,583	106,666	24
Lemons and limes	70,128	6,461	9	149,513	17,498	12	272,441	44,435	16	376,758	94,356	25
Grapefruit and pomelo	27,603	6,645	24	79,310	15,664	20	156,681	25,926	17	273,532	82,852	30
Citrus fruit n.e.s.	350	258	74	972	908	93	3,127	1,580	51	8,501	5,111	60
Tropical fruits	45,638	37,346	82	88,972	69,298	78	182,343	120,219	66	503,526	296,282	59
Mangoes	964	962	100	2,435	2,382	98	10,192	9,643	95	35,084	31,102	89
Avocados	151	151	100	4,087	576	14	22,279	975	4	90,187	10,080	11
Pineapples	6,397	5,499	86	21,997	18,675	85	36,283	32,011	88	96,840	84,898	88
Dates	35,930	28,767	80	51,198	40,795	80	86,982	65,408	75	139,827	112,103	80
Persimmons	400	400	100	2,267	2,267	100	4,300	4,300	100	8,968	6,092	68
Papayas	0	0	0	1,767	38	2	8,222	39	0	6,700	2,538	38
Fruit, tropical fresh n.e.s.	1,797	1,567	87	5,222	4,566	87	14,086	7,843	56	125,919	49,470	39
Miscellaneous fruits	551,417	88,416	16	1,047,643	163,648	16	2,251,582	348,006	15	3,404,704	756,455	22
Apples	226,661	50,117	22	406,325	74,381	18	906,058	173,097	19	1,136,493	222,549	20
Pears	57,905	5,797	10	104,971	18,993	18	206,660	43,253	21	291,978	72,197	25
Quinces	142	23	16	261	75	29	969	509	52	1,095	857	78
Apricots	10,000	1,259	13	14,984	1,482	10	26,262	2,270	9	47,261	3,616	8
Sour cherries	1,524	8	1	2,549	11	0	4,163	0	0	4,184	0	0
Cherries	11,754	181	2	24,599	393	2	57,628	1,314	2	75,112	5,643	8
Peaches and nectarines	47,352	903	2	115,607	2,296	2	283,449	6,221	2	344,277	23,803	7
Plums	14,566	894	6	26,472	1,541	6	54,839	3,673	7	83,280	18,725	22

(continued)

Table 40—Continued

Commodity	1961-63 World	1961-63 Developing Countries	1961-63 Developing Countries' Share	1970-72 World	1970-72 Developing Countries	1970-72 Developing Countries' Share	1975-77 World	1975-77 Developing Countries	1975-77 Developing Countries' Share	1983-85 World	1983-85 Developing Countries	1983-85 Developing Countries' Share
	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)
Stone fruit n.e.s.	783	193	25	3,179	550	17	4,142	1,559	38	12,046	6,416	53
Strawberries	13,702	137	1	69,653	8,761	13	147,822	6,535	4	212,596	4,738	2
Raspberries	2,606	0	0	2,675	0	0	4,246	0	0	14,436	0	0
Gooseberries	81	0	0	392	0	0	1,385	1	0	4,245	0	0
Currants	2,439	0	0	8,476	0	0	9,396	0	0	4,415	4	0
Blueberries	2,698	0	0	2,860	0	0	3,824	0	0	10,527	0	0
Cranberries	4	0	0	16	0	0	79	0	0	390	0	0
Berries n.e.s.	6,483	2	0	6,666	77	1	12,430	301	2	19,894	257	1
Grapes	119,946	11,878	10	183,673	21,227	12	377,183	48,629	13	745,557	227,145	30
Watermelons	9,600	5,369	56	22,125	7,373	33	42,258	11,180	26	104,472	54,679	52
Cantaloupes and other melons	11,290	7,983	71	30,927	16,962	55	64,214	27,260	42	112,001	38,347	34
Figs	104	35	34	326	15	5	756	128	17	2,997	1,560	52
Fruit, fresh n.e.s.	11,778	3,637	31	20,907	9,512	45	43,821	22,078	50	177,450	75,919	43
Treenuts	164,295	123,418	75	306,924	232,452	76	545,734	414,545	76	727,363	512,964	71
Brazil nuts	8,889	7,656	86	11,217	8,863	79	15,293	13,195	86	19,647	17,123	87
Cashew nuts	21,826	21,797	100	38,537	38,411	100	42,434	40,939	96	41,492	36,207	87
Chestnuts	10,388	4,278	41	26,918	13,495	50	47,866	28,112	59	116,082	84,594	73
Almonds	13,664	10,382	76	20,995	15,110	72	21,963	13,955	64	37,602	13,436	36
Walnuts	20,984	7,068	34	33,909	13,185	39	78,229	28,967	37	104,764	39,347	38
Pistachios	7,523	6,582	87	22,084	20,778	94	54,160	50,316	93	56,685	39,400	70
Kolanuts	1,590	1,590	100	4,117	4,117	100	4,809	4,809	100	5,131	5,131	100
Hazelnuts (filberts)	58,071	50,074	86	108,379	97,104	90	215,968	198,505	92	198,183	181,379	92
Areca nuts (betel)	1,193	1,193	100	1,022	1,022	100	3,648	3,609	99	20,933	20,872	100
Nuts n.e.s.	16,182	10,021	62	31,643	15,399	49	46,071	22,701	49	90,553	48,745	54
Coconuts	2,177	2,157	99	3,487	3,134	90	8,085	6,780	84	14,666	12,382	84
Olives	150	21	14	360	206	57	1,148	916	80	701	149	21
Melonseed	1,656	598	36	4,258	1,627	38	6,061	1,743	29	20,923	14,199	68
Processed fruits	910,832	244,996	27	1,763,694	546,690	31	3,661,250	1,204,678	33	6,771,743	2,776,255	41
Juices (nontropical)	92,283	12,537	14	297,058	54,073	18	757,735	175,399	23	2,183,009	1,053,220	48
Orange juice, single-strength	24,220	4,167	17	79,075	10,048	13	139,178	17,862	13	259,760	43,380	17
Orange juice, concentrated	26,229	3,245	12	66,861	32,282	48	195,508	121,729	62	1,159,941	935,345	81

(continued)

Table 40—Continued

Commodity	1961-63			1970-72			1975-77			1983-85		
	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share
	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)
Tangerine juice	0	0	0	0	0	0	910	910	100	8,638	8,638	100
Lemon juice, single-strength	4,385	1,298	30	10,809	1,747	16	22,934	4,147	18	30,647	5,248	17
Lemon juice, concentrated	0	0	0	78	4	5	753	494	66	8,412	2,128	25
Grapefruit juice, single-strength	5,833	1,484	25	21,069	1,336	6	26,714	869	3	23,466	724	3
Grapefruit juice, concentrated	3,092	306	10	5,360	499	9	8,003	1,062	13	56,449	4,414	8
Citrus juice, single-strength	421	400	95	1,211	784	65	3,721	928	25	3,732	1,450	39
Citrus juice, concentrated	52	0	0	316	0	0	1,642	0	0	5,109	1,045	20
Apple juice, single-strength	543	0	0	7,021	0	0	19,617	0	0	53,328	1	0
Apple juice, concentrated	193	0	0	10,326	0	0	27,914	0	0	133,961	0	0
Plum juice, single-strength	0	0	0	0	0	0	0	0	0	0	0	0
Plum juice, concentrated	0	0	0	0	0	0	0	0	0	0	0	0
Fruit juice n.e.s.	27,315	1,637	6	94,930	7,373	8	310,841	27,399	9	439,567	50,848	12
Juices (tropical)	4,992	1,265	25	12,177	7,473	61	18,972	12,481	66	77,486	46,381	60
Pineapple juice, single-strength	2,102	1,265	60	8,408	4,568	54	14,121	8,355	59	64,132	33,961	53
Pineapple juice, concentrated	2,890	0	0	3,769	2,905	77	4,851	4,125	85	13,113	12,179	93
Mango juice	0	0	0	0	0	0	0	0	0	240	240	100
Mango pulp	0	0	0	0	0	0	0	0	0	1	1	100
Other nontropical fruits	523,313	88,868	17	866,792	192,462	22	1,782,005	431,122	24	2,585,105	709,118	27
Dried apricots	3,440	1,022	30	5,618	2,328	41	14,995	10,051	67	37,330	32,171	86
Plums, dried (prunes)	31,225	2,062	7	38,454	4,739	12	79,580	11,194	14	122,376	9,980	8
Raisins	106,533	32,620	31	141,415	50,490	36	332,534	139,464	42	453,296	176,155	39
Figs, dried	13,208	8,734	66	14,484	9,240	64	33,956	22,579	66	45,134	32,229	71
Fruit, dried, n.e.s.	16,105	4,714	29	24,114	11,026	46	38,911	15,553	40	82,867	22,398	27
Fruit, prepared, n.e.s.	352,473	39,567	11	641,709	114,464	18	1,277,105	230,350	18	1,837,960	435,478	24
Flour of fruit	330	149	45	997	175	18	4,924	1,930	39	6,143	707	12

(continued)

Table 40—Continued

Commodity	1961-63 World	1961-63 Developing Countries	1961-63 Developing Countries' Share	1970-72 World	1970-72 Developing Countries	1970-72 Developing Countries' Share	1975-77 World	1975-77 Developing Countries	1975-77 Developing Countries' Share	1983-85 World	1983-85 Developing Countries	1983-85 Developing Countries' Share
	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)
Other tropical fruits	73,462	50,965	69	125,150	100,031	80	252,628	214,243	85	360,940	315,059	87
Pineapples, canned	71,874	49,393	69	122,888	97,996	80	247,086	209,080	85	358,034	312,557	87
Fruit, tropical, dried, n.e.s.	1,587	1,571	99	2,262	2,034	90	5,542	5,164	93	2,906	2,502	86
Treenuts	216,783	91,362	42	462,518	192,652	42	849,911	371,433	44	1,565,204	642,476	41
Brazilnuts, shelled	4,425	4,425	100	7,803	7,803	100	13,954	13,954	100	15,134	15,134	100
Cashew nuts, shelled	43,503	43,503	100	109,528	109,528	100	197,726	197,726	100	258,306	258,306	100
Almonds, shelled	80,099	8,609	11	137,995	15,881	12	211,571	20,938	10	394,523	19,852	5
Walnuts, shelled	5,903	1,533	26	9,450	3,233	34	19,389	5,157	27	43,282	16,616	38
Hazelnuts, shelled	16,613	0	0	32,965	0	0	51,092	4,397	9	207,726	87,559	42
Prepared nuts[a]	302	0	0	28,872	0	0	70,060	870	1	221,094	39,059	18
Prepared groundnuts	4	0	0	2,541	321	13	7,983	954	12	18,345	3,235	18
Coconuts, desiccated	28,462	28,284	99	38,566	38,237	99	86,343	83,607	97	163,994	155,994	95
Olives, preserved	37,473	5,007	13	94,798	17,649	19	191,792	43,831	23	242,799	46,721	19
Total fruits	2,476,122	939,961	38	4,596,979	1,765,040	38	9,139,111	3,351,368	37	15,196,301	6,424,672	42

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: n.e.s. is "not elsewhere specified."
[a] Excludes groundnuts.

Table 41—Growth rates of fruit export values in the world and developing countries, 1965-75 and 1975-85

Commodity	World		Developing Countries	
	1965-75	1975-85	1965-75	1975-85
		(percent)		
Fresh fruits	9.55	7.73	5.51	6.85
Bananas and plantains	5.19	6.66	5.05	6.71
Bananas	5.19	6.58	5.05	6.62
Plantains	4.77	17.74	4.77	17.74
Citrus fruits	9.78	4.57	9.12	6.60
Oranges	7.51	3.81	8.39	5.53
Tangerines and mandarins	15.13	6.04	6.72	3.91
Lemons and limes	11.77	3.88	19.72	10.07
Grapefruit and pomelo	15.33	6.98	13.25	15.63
Citrus fruit n.e.s.	16.61	11.43	15.65	14.35
Tropical fruits	11.78	13.32	11.25	11.72
Mangoes	22.58	18.06	22.20	17.32
Avocados	42.22	19.12	19.52	31.01
Pineapples	14.12	12.49	14.86	12.42
Dates	8.44	5.85	8.76	6.58
Persimmons	19.23	10.52	19.23	5.94
Papayas	12.58	−3.24	10.09	66.47
Fruit, tropical fresh n.e.s.	15.43	31.51	11.70	25.70
Miscellaneous fruits	11.35	5.40	9.73	10.03
Apples	11.56	3.15	9.19	3.14
Pears	10.20	4.79	10.64	6.93
Qunices	13.28	1.81	37.28	7.94
Apricots	8.67	7.02	7.86	5.46
Sour cherries	16.69	−0.68	6.55	0.00
Cherries	16.64	3.23	24.03	19.26
Peaches and nectarines	13.03	2.63	13.31	19.02
Plums	8.78	5.24	13.13	22.64
Stone fruit n.e.s.	19.65	13.77	10.95	16.33
Strawberries	18.73	4.19	21.18	−7.09
Raspberries	3.50	16.61	0.00	0.00
Gooseberries	25.99	15.74	0.00	0.00
Currants	10.63	−10.27	0.00	−15.28
Blueberries	−5.25	15.63	0.00	0.00
Cranberries	−4.85	33.80	0.00	0.00
Berries n.e.s.	9.67	7.10	85.40	−0.20
Grapes	8.52	8.74	9.06	20.81
Watermelons	13.40	11.72	6.94	21.19
Cantaloupes and other melons	11.41	6.92	8.44	3.40
Figs	12.32	17.83	10.82	38.80
Fruit, fresh n.e.s.	11.65	19.46	12.15	17.52
Treenuts	9.75	3.19	9.89	1.76
Brazil nuts	6.79	2.03	6.70	1.88
Cashew nuts	5.95	1.18	5.84	0.05
Chestnuts	10.13	10.51	10.92	13.34
Almonds	11.30	6.34	13.20	−3.14
Walnuts	10.68	4.25	12.22	4.02
Pistachios	13.85	0.44	13.98	−3.26
Kolanuts	3.71	1.67	3.71	1.67
Hazelnuts (filberts)	10.15	−8.48	10.37	−19.55
Areca nuts (betel)	7.88	23.63	7.84	23.75
Nuts n.e.s.	10.28	9.07	10.85	9.82
Coconuts	8.49	7.22	9.67	7.44
Olives	−14.37	−3.10	−18.86	−16.06
Melonseed	11.97	16.61	14.91	29.06

(continued)

Table 41—Continued

	World		Developing Countries	
Commodity	1965-75	1975-85	1965-75	1975-85
		(percent)		
Processed fruits	11.86	11.73	8.05	11.17
Juices (nontropical)	21.04	13.89	21.93	24.60
Orange juice, single-strength	17.52	8.27	10.21	13.08
Orange juice, concentrated	20.91	23.98	31.86	28.08
Tangerine juice	0.00	32.39	0.00	39.12
Lemon juice, single-strength	13.66	4.57	3.86	−0.32
Lemon juice, concentrated	92.13	30.31	111.12	16.01
Grapefruit juice, single-strength	13.92	−0.53	0.69	−1.53
Grapefruit juice, concentrated	20.01	26.29	16.01	21.05
Citrus juice, single-strength	12.95	1.09	6.32	6.80
Citrus juice, concentrated	54.66	14.71	0.00	35.11
Apple juice, single-strength	24.03	15.16	0.00	−47.68
Apple juice, concentrated	41.84	21.46	0.00	−8.45
Plum juice, single-strength	0.00	−38.15	0.00	−38.15
Plum juice, concentrated	0.00	26.71	0.00	26.71
Fruit juice n.e.s.	24.62	4.52	20.24	9.80
Juices (tropical)	9.48	19.18	14.85	17.77
Pineapple juice, single-strength	7.12	20.74	11.01	18.91
Pineapple juice, concentrated	21.78	13.36	26.16	15.02
Mango juice	0.00	202.30	0.00	202.30
Mango pulp	0.00	0.00	0.00	0.00
Other nontropical fruits	10.02	4.87	13.61	6.62
Dried apricots	9.88	12.40	17.31	15.78
Plums, dried (prunes)	8.72	6.16	14.70	−2.04
Raisins	8.85	4.17	13.65	3.07
Figs, dried	9.66	3.56	10.07	4.64
Fruit, dried, n.e.s.	6.47	9.29	10.24	4.35
Fruit, prepared, n.e.s.	10.54	4.73	14.21	8.58
Flour of fruit	31.52	3.25	16.92	−8.93
Other tropical fruits	8.01	4.70	8.62	5.09
Pineapples, canned	8.00	4.87	8.63	5.29
Fruit, tropical, dried, n.e.s.	8.58	−6.72	7.86	−7.75
Treenuts	10.39	8.04	9.18	7.71
Brazilnuts shelled	8.76	0.55	8.76	0.55
Cashew nuts shelled	12.05	4.87	12.05	4.87
Almonds, shelled	6.13	7.28	−2.49	−1.88
Walnuts, shelled	7.60	11.17	2.23	16.23
Hazelnuts, shelled	9.15	15.77	0.00	17.98
Prepared nuts[a]	41.64	15.76	0.00	122.96
Prepared groundnuts	24.54	13.31	37.57	16.94
Coconuts, desiccated	6.96	8.46	6.89	8.18
Olives, preserved	13.59	3.20	15.04	0.69
Total fruits	10.29	8.97	6.57	8.51

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: n.e.s. is "not elsewhere specified."
[a] Excludes groundnuts.

Table 42—Three-year average export values of vegetables, by commodity, and share of developing countries in world trade, 1961-85

Commodity	1961-63			1970-72			1975-77			1983-85		
	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share	World	Developing Countries	Developing Countries' Share
	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)
Fresh vegetables	773,631	171,034	22	1,452,058	376,407	26	3,108,964	612,182	20	4,476,262	1,052,482	23
Roots and tubers	185,624	36,417	20	291,042	52,004	18	886,780	145,461	16	879,033	208,461	24
Potatoes	184,081	35,475	19	281,447	47,075	17	865,778	128,235	15	813,338	149,674	18
Sweet potatoes	671	196	29	2,941	1,249	42	4,334	3,238	75	12,093	9,022	75
Yautia	30	30	100	783	783	100	2,420	2,420	100	5,029	5,029	100
Taro	97	97	100	314	314	100	1,180	1,180	100	2,843	2,843	100
Yams	58	54	93	1,410	1,395	99	3,450	3,342	97	11,979	11,824	99
Roots and tuber n.e.s.	687	565	82	4,147	1,188	29	9,618	7,046	73	33,752	30,070	89
Hops	47,818	49	0	74,508	6	0	108,445	21	0	208,269	5,562	3
Miscellaneous vegetables	540,190	134,569	25	1,086,508	324,397	30	2,113,739	466,700	22	3,338,960	838,459	25
Sugarcane	9,821	9,821	100	9,587	9,569	100	10,647	10,647	100	20.908	20,901	100
Sugar beets	3,720	18	0	726	12	2	13,392	15	0	6,958	51	1
Cabbages	14,568	1,277	9	27,031	3,047	11	69,405	9,266	13	113,089	18,898	17
Artichokes	4,494	3,574	80	8,328	1,208	15	14,948	428	3	18,924	1,222	6
Asparagus	6,654	155	2	19,683	820	4	35,931	1,162	3	92,491	4,151	4
Lettuce	63,850	14	0	117,740	2	0	219,227	37	0	280,105	295	0
Spinach	1,879	0	0	935	0	0	2,203	66	3	4,499	272	6
Tomatoes	170,729	47,790	28	362,599	144,148	40	623,610	203,811	33	949,245	279,858	29
Cauliflower	18,696	147	1	33,652	1,324	4	68,319	1,101	2	105,403	4,299	4
Pumpkins, squash, gourds	1,119	166	15	4,255	3,835	90	13,835	4,946	36	50,797	13,401	26
Cucumbers and gherkins	28,625	0	0	80,229	4,535	6	197,354	9,160	5	282,671	49,635	18
Eggplants	862	670	78	6,311	1,860	29	15,163	5,161	34	37,979	11,958	31
Chilies and peppers, green	8,164	582	7	25,305	2,779	11	77,082	2,561	3	190,961	7,944	4
Onions and shallots, green	1,252	876	70	4,142	2,800	68	13,988	4,327	31	39,615	11,862	30
Onions, dry	67,004	24,540	37	111,522	31,890	29	245,053	64,137	26	311,450	105,172	34
Garlic	11,958	4,725	40	25,366	14,611	58	59,933	37,794	63	80,413	54,703	68
Beans, green	11,487	1,953	17	16,504	2,536	15	33,375	3,747	11	37,479	13,746	37
Peas, green	1,698	604	36	2,629	736	28	5,610	922	16	12,125	2,916	24
Broad beans, green	477	140	29	1,279	94	7	1,880	415	22	4,971	404	8

(continued)

Table 42—Continued

Commodity	1961-63 World	1961-63 Developing Countries	1961-63 Developing Countries' Share	1970-72 World	1970-72 Developing Countries	1970-72 Developing Countries' Share	1975-77 World	1975-77 Developing Countries	1975-77 Developing Countries' Share	1983-85 World	1983-85 Developing Countries	1983-85 Developing Countries' Share
	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)
String beans	0	0	0	16	16	100	6	6	100	104	104	100
Carrots	25,278	4,874	19	30,687	2,126	7	78,198	2,101	3	116,715	4,009	3
Okra	0	0	0	0	0	0	0	0	0	370	370	100
Green corn (maize)	0	0	0	0	0	0	0	0	0	27	0	0
Mushrooms	7,967	226	3	16,590	1,464	9	35,272	6,901	20	90,240	29,706	33
Chicory roots	1,638	0	0	2,476	0	0	3,983	186	5	3,917	2	0
Vegetable products, fresh or dried	3,979	464	12	8,741	2,968	34	18,659	8,198	44	44,195	10,219	23
Carobs	6,531	2,393	37	11,141	6,572	59	16,247	7,847	48	29,996	10,213	34
Vegetables, fresh, n.e.s.	67,740	29,560	44	159,032	85,444	54	240,421	81,758	34	463,312	182,150	39
Processed vegetables	495,673	131,509	26	1,225,312	394,582	30	2,964,632	910,717	31	5,103,077	1,609,086	32
Roots and tubers	5,512	4,540	82	13,185	3,057	23	72,039	6,603	9	252,001	8,059	3
Flour of potatoes	886	145	16	9,974	1,099	11	65,513	2,649	4	58,125	3,837	7
Frozen potatoes	0	0	0	1	0	0	485	0	0	187,797	12	0
Potato, tapioca	281	154	55	354	6	2	566	7	1	1,611	31	2
Flour of roots and tubers	4,336	4,232	98	2,783	1,950	70	5,475	3,946	72	4,469	4,180	94
Roots and tubers, dried	10	10	100	74	3	4	0	0	0	0	0	0
Pulses	187,758	95,687	51	326,433	163,240	50	717,487	376,767	53	1,282,306	622,985	49
Beans, dry	79,355	33,700	42	139,761	69,410	50	341,173	178,300	52	515,439	298,536	58
Broad beans, dry	11,840	11,423	96	20,362	19,605	96	29,103	26,432	91	69,340	36,141	52
Peas, dry	47,903	8,400	18	73,285	10,427	14	141,556	13,283	9	339,950	4,003	1
Chickpeas	14,547	13,178	91	23,621	21,919	93	46,360	44,958	97	111,580	110,302	99
Cow peas, dry	496	496	100	583	583	100	8,129	8,129	100	6,117	6,117	100
Pigeon peas	2,069	2,069	100	3,499	3,499	100	4,007	4,007	100	6,052	6,052	100
Lentils	14,142	11,522	81	30,418	18,660	61	95,876	70,474	74	156,150	106,161	68
Pulses n.e.s.	16,128	13,933	86	33,831	18,576	55	48,859	29,792	61	69,371	48,943	71
Flour of pulses	1,276	966	76	1,073	561	52	2,423	1,392	57	8,307	6,730	81
Miscellaneous vegetables	302,403	31,282	10	885,693	183,284	21	2,175,106	527,348	24	3,568,770	978,042	27
Tomato juice, concentrated	0	0	0	3	0	0	50	0	0	5	0	0
Tomato juice, single-strength	6,943	34	0	13,067	126	1	29,469	2,644	9	33,896	10,497	31
Tomato paste	54,999	1,143	2	120,018	5,033	4	309,647	33,927	11	504,170	59,780	12

(continued)

Table 42—Continued

Commodity	1961-63 World	1961-63 Developing Countries	1961-63 Developing Countries' Share	1970-72 World	1970-72 Developing Countries	1970-72 Developing Countries' Share	1975-77 World	1975-77 Developing Countries	1975-77 Developing Countries' Share	1983-85 World	1983-85 Developing Countries	1983-85 Developing Countries' Share
	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)	(US$ 1,000)		(percent)
Peeled tomatoes	32,646	0	0	65,191	88	0	118,696	3,160	3	266,634	10	0
Dried mushrooms	3,256	603	19	9,334	1,085	12	23,067	8,517	37	52,897	25,528	48
Canned mushrooms	8,064	0	0	41,509	0	0	137,773	36,554	27	295,847	90,919	31
Vegetables, dried n.e.s.	628	0	0	3,964	72	2	5,926	246	4	7,936	566	7
Vegetables, canned n.e.s.	44,958	7,804	17	60,991	33,950	56	150,612	91,645	61	293,202	208,930	71
Juice of vegetables n.e.s.	455	384	84	5,561	1,739	31	13,969	5,676	41	14,472	4,901	34
Vegetables, dehydrated	34,021	8,475	25	92,610	20,323	22	207,509	57,379	28	371,399	112,775	30
Vegetables preserved by vinegar	14,466	647	4	51,494	3,165	6	119,445	9,704	8	191,457	28,309	15
Vegetables, prepared n.e.s.	75,246	10,811	14	346,044	107,405	31	793,255	231,206	29	930,798	302,184	32
Vegetables, frozen	21,263	101	0	53,123	1,662	3	207,609	16,174	8	506,740	80,497	16
Vegetables, temporarily preserved	5,459	1,280	23	22,785	8,635	38	58,080	30,516	53	99,317	53,146	54
Total vegetables	1,269,305	302,544	24	2,677,370	725,989	27	6,073,596	1,522,900	25	9,599,340	2,661,569	28

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: n.e.s. is "not elsewhere specified."

Table 43—Growth rates of vegetable export values in the world and developing countries, 1965-75 and 1975-85

Commodity	World		Developing Countries	
	1965-75	1975-85	1965-75	1975-85
		(percent)		
Fresh vegetables	10.21	5.11	7.07	7.49
Roots and tubers	10.07	1.09	8.95	6.03
Potatoes	9.76	0.44	7.40	3.70
Sweet potatoes	24.23	12.63	26.31	12.58
Yautia	40.43	10.17	40.43	10.17
Taro	22.71	11.06	22.71	11.06
Yams	33.37	16.23	33.82	16.52
Roots and tubers n.e.s.	26.14	16.19	24.43	18.84
Hops	8.64	8.89	−10.86	90.96
Miscellaneous vegetables	10.38	6.25	6.71	7.87
Sugarcane	11.97	14.04	12.04	14.03
Sugar beets	−3.21	−2.75	−11.86	27.50
Cabbages	11.38	7.38	15.98	9.75
Artichokes	8.73	2.25	−11.34	13.60
Asparagus	14.84	12.22	24.73	18.15
Lettuce	10.06	3.10	24.49	25.76
Spinach	4.29	9.49	0.00	40.03
Tomatoes	10.17	5.39	8.70	4.34
Cauliflower	10.66	5.55	39.67	20.18
Pumpkins, squash, gourds	30.42	16.88	24.71	12.37
Cucumbers and gherkins	14.80	4.22	21.43	21.85
Eggplants	20.44	12.36	17.20	10.69
Chilies and peppers, green	16.28	12.38	15.29	14.11
Onions and shallots, green	9.81	16.53	7.50	12.96
Onions, dry	10.60	3.83	4.64	7.69
Garlic	14.28	4.20	18.00	5.00
Beans, green	6.78	1.95	10.68	16.56
Peas, green	8.65	9.99	7.13	13.08
Broad beans, green	12.66	13.43	−2.43	0.98
String beans	−45.66	67.56	−45.66	63.79
Carrots	8.95	6.62	−4.70	10.90
Okra	0.00	22.70	0.00	22.70
Green corn (maize)	0.00	29.02	0.00	0.00
Mushrooms	7.31	11.32	18.91	17.12
Chicory roots	4.09	0.02	0.00	−41.40
Vegetable products, fresh or dried	18.43	11.96	22.95	2.79
Carobs	8.36	8.87	6.90	4.58
Vegetables, fresh n.e.s.	6.68	8.64	−2.20	10.49
Processed vegetables	15.22	7.34	15.36	7.79
Roots and tubers	18.93	18.85	2.38	3.00
Flour of potatoes	27.72	0.19	27.61	5.50
Frozen potatoes	193.20	102.81	0.00	0.00
Potato, tapioca	−3.98	12.91	−38.79	18.06
Flour of roots and tubers	1.19	−1.56	−0.98	0.78
Roots and tubers, dried	69.37	0.00	−0.76	0.00
Pulses	10.59	8.19	10.03	6.98
Beans, dry	14.39	6.58	12.85	7.18
Broad beans, dry	5.65	12.93	4.86	5.73
Peas, dry	5.34	11.24	1.13	−16.12
Chickpeas	9.66	11.23	9.98	11.67
Cow peas, dry	−18.82	−19.31	−18.82	−19.31
Pigeon peas	−3.43	5.45	−3.43	5.45
Lentils	14.62	7.15	14.64	5.98
Pulses n.e.s.	10.13	4.70	7.27	8.09
Flour of pulses	11.29	16.03	12.09	21.95

(continued)

Table 43—Continued

Commodity	World 1965-75	World 1975-85	Developing Countries 1965-75	Developing Countries 1975-85
		(percent)		
Miscellaneous vegetables	17.39	6.54	23.05	8.39
Tomato juice, concentrated	-29.03	-7.66	0.00	0.00
Tomato juice, single-strength	13.14	1.83	39.87	22.61
Tomato paste	16.18	6.53	32.22	8.08
Peeled tomatoes	14.11	10.46	81.76	-43.61
Dried mushrooms	27.26	10.95	24.78	15.37
Canned mushrooms	25.94	10.84	-1.67	12.68
Vegetables, dried n.e.s	5.69	6.22	10.87	4.17
Vegetables, canned n.e.s.	11.44	8.99	23.60	11.27
Juice of vegetables n.e.s.	28.76	0.88	21.25	-0.62
Vegetables, dehydrated	15.11	7.73	18.62	9.01
Vegetables, preserved by vinegar	19.45	5.42	27.82	14.41
Vegetables, prepared n.e.s.	19.62	2.19	20.90	3.92
Vegetables, frozen	18.43	12.69	57.24	24.22
Vegetables, temporarily preserved	14.83	6.55	23.54	7.17
Total vegetables	12.53	6.25	11.39	7.67

Source: Data on horticultural products compiled by the author from various FAO sources.
Note: n.e.s. is "not elsewhere specified."

Table 44—Three-year average values of agricultural and horticultural exports of selected developing countries and regions and their share of world trade, 1961-85

Country	1961-63				1970-72			
	Agriculture	Fruits and Vegetables	Market Share	Fruits and Vegetables/ Agriculture	Agriculture	Fruits and Vegetables	Market Share	Fruits and Vegetables/ Agriculture
	(US$ million)		(percent)		(US$ million)		(percent)	
Brazil	1,129.84	24.05	0.64	2.13	2,196.27	75.80	1.03	3.45
Turkey	328.43	90.43	2.40	27.53	570.61	182.19	2.48	31.93
China (excluding Taiwan)	n.a.	64.10	1.70	n.a.	n.a.	172.33	2.34	n.a.
China (Taiwan Province)	n.a.	37.74	1.00	n.a.	n.a.	221.16	3.00	n.a.
Mexico	499.79	53.62	1.42	10.73	752.05	188.03	2.55	25.00
Philippines	419.85	26.62	0.70	6.34	531.36	65.75	0.89	12.37
Chile	30.69	16.92	0.45	55.13	41.00	24.95	0.34	60.86
Thailand	390.57	5.80	0.15	1.49	581.26	21.99	0.61	3.78
Morocco	156.17	100.48	2.66	64.34	254.05	195.14	2.65	76.81
Argentina	1,103.02	41.18	1.09	3.73	1,481.73	86.64	1.18	5.85
Honduras	62.06	38.65	1.02	62.28	137.03	90.26	1.23	65.86
Costa Rica	81.92	21.02	0.56	25.66	190.12	73.58	1.00	38.70
India	640.86	57.68	1.53	9.00	715.26	102.52	1.39	14.33
Hong Kong	91.70	17.39	0.46	18.97	129.63	24.07	0.33	18.57
Colombia	365.65	12.81	0.34	3.50	588.08	18.27	0.25	3.11
Singapore	212.54	27.45	0.73	12.92	278.73	36.57	0.50	13.12
Egypt	338.30	28.11	0.74	8.31	527.22	47.81	0.65	9.07
Cuba	596.06	4.21	0.11	0.71	749.49	5.01	0.07	0.67
Ecuador	130.98	85.32	2.26	65.14	191.89	99.63	1.35	51.92
Afghanistan	32.56	13.05	0.35	40.07	72.31	34.04	0.46	47.08
Korea, Republic of	15.32	0.42	0.01	2.75	98.14	11.95	0.16	12.17
Cyprus	25.21	18.99	0.50	75.31	70.78	55.34	0.75	78.18
Lebanon	33.48	17.55	0.46	52.41	83.11	38.59	0.52	46.43
Guatemala	112.93	11.16	0.30	9.88	212.48	21.23	0.29	9.99
Côte d'Ivoire	147.41	14.30	0.38	9.70	332.49	35.29	0.48	10.62
Panama	18.10	15.20	0.40	83.96	74.76	63.27	0.66	84.63
Malaysia	596.45	20.58	0.54	3.45	712.95	26.68	0.36	3.74
Kenya	115.59	4.17	0.11	3.61	189.12	14.27	0.19	7.54
Martinique	33.02	17.35	0.46	52.54	32.30	23.93	0.33	74.08
Jordan	8.97	6.20	0.16	69.12	15.18	10.81	0.15	71.20
Iran	69.31	24.10	0.64	34.77	167.34	42.56	0.58	25.43
Total	7,786.76	916.64	24.27	11.77	11,976.74	2,169.62	27.81	17.61
Developing market economies	13,173.61	1,132.45	30.38	8.60	18,618.70	2,085.65	28.71	11.22
Africa	2,829.25	305.38	8.16	10.79	4,002.90	433.57	5.96	10.83
Latin America	5,211.29	409.92	10.24	7.87	8,010.66	856.11	11.77	10.69
Near East	1,262.43	228.72	6.11	18.12	2,106.64	472.93	6.50	22.45
Far East	3,781.78	183.58	4.90	4.85	4,355.45	320.17	4.40	7.35
Other developing market economies	88.87	4.84	0.48	5.45	143.05	5.87	0.08	4.11
Asian centrally planned economies	722.44	110.06	2.94	15.23	1,478.96	402.37	5.53	27.21
World	34,131.00	3,745.43	100	10.97	57,919.55	7,274.35	100	12.56
Developed[a]	20,234.95	2,502.95	66.63	12.37	37,821.88	4,783.32	65.76	12.65
Developing[b]	13,896.05	1,242.51	33.17	8.94	20.097.66	2,491.03	34.24	12.39
China (main and Taiwan)	512.96	101.84	2.79	19.85	1,327.72	393.48	5.41	29.64

1975-77				1983-85				Rates of Growth	
Agriculture	Fruits and Vegetables	Market Share	Fruits and Vegetables/Agriculture	Agriculture	Fruits and Vegetables	Market Share	Fruits and Vegetables/Agriculture	1965-75	1975-85
(US$ million)		(percent)		(US$ million)		(percent)		(percent)	
6,162.30	225.45	1.45	3.66	9,604.54	1,140.35	4.44	11.87	19.10	21.34
1,128.80	424.33	2.72	37.59	2,313.49	911.17	3.55	39.38	12.90	10.55
n.a.	322.84	2.07	n.a.	n.a.	552.39	2.15	n.a.	10.73	7.10
n.a.	344.40	2.21	n.a.	n.a.	544.50	2.12	n.a.	6.07	6.36
1,242.88	328.65	2.11	26.44	1,637.20	510.62	1.99	31.19	11.07	5.64
1,364.86	194.59	1.25	14.26	1,382.87	357.90	1.39	25.88	18.03	8.51
171.21	87.00	0.56	50.81	449.50	344.26	1.34	76.59	13.82	19.17
1,908.82	92.55	2.67	4.85	3,468.69	295.96	1.19	8.53	20.28	16.56
350.51	276.35	1.77	78.84	326.47	291.57	1.14	89.31	7.34	0.09
3,049.43	250.45	1.61	8.21	5,888.07	273.65	1.07	4.65	13.25	1.39
266.00	107.08	0.69	40.26	529.10	258.58	1.01	48.87	0.01	12.58
469.93	156.09	1.00	33.22	619.80	243.66	0.95	39.31	17.67	5.70
1,780.20	190.16	1.22	10.68	2,322.60	240.28	0.94	10.35	7.82	4.73
354.12	56.19	0.36	15.87	1,291.15	189.12	0.74	14.65	9.95	17.36
1,438.78	55.63	0.36	3.87	2,283.60	176.70	0.69	7.74	5.26	15.32
640.77	71.27	0.46	11.12	1,808.55	168.37	0.66	9.31	5.69	11.54
779.51	134.42	0.85	17.24	721.82	167.12	0.65	23.15	14.66	3.67
3,270.54	22.20	0.14	0.68	5,178.18	162.07	0.63	3.13	26.21	27.51
454.74	132.77	0.85	29.20	500.29	161.20	0.63	32.22	2.63	3.34
204.22	90.28	0.58	44.21	225.28	131.35	0.51	58.31	14.43	3.99
380.85	64.85	0.42	17.03	541.80	126.07	0.49	23.27	45.43	8.20
128.89	85.76	0.55	66.54	198.03	118.52	0.46	59.85	10.65	4.98
80.75	53.45	0.34	66.19	146.37	110.13	0.43	75.24	0.51	8.28
651.38	31.79	0.20	4.88	712.33	103.24	0.40	14.49	13.36	16.95
1,143.84	65.76	0.42	5.75	1,764.77	84.09	0.33	4.76	12.86	3.12
111.09	65.24	0.42	58.73	153.63	81.66	0.32	53.15	6.45	2.56
2,045.65	53.74	0.34	2.63	4,040.63	81.27	0.32	2.01	7.15	5.38
542.25	40.32	0.26	7.44	685.47	77.57	0.30	11.32	13.62	9.04
85.10	70.49	0.45	82.84	92.67	75.05	0.29	80.99	3.59	1.15
67.06	43.78	0.28	65.28	136.79	69.57	0.27	50.86	9.09	7.12
301.02	93.13	0.60	30.94	106.94	68.01	0.26	63.60	15.77	−4.26
30,575.48	4,231.03	29.21	13.84	49,130.62	8,115.98	32.76	16.52	10.68	8.74
43,815.44	4,544.10	27.56	10.37	64,240.04	7,961.54	32.14	12.39	9.95	8.58
8,023.62	639.86	4.21	7.97	8,488.31	635.90	2.57	7.49	7.08	−0.11
20,668.20	1,698.57	11.15	8.22	30,937.94	3,864.80	15.60	12.49	9.43	10.76
3,715.36	1,066.39	7.01	28.70	5,144.37	1,816.96	7.33	35.32	12.71	7.23
11,036.82	782.97	5.15	7.09	19,108.51	1,635.05	6.60	8.56	11.41	10.20
371.64	5.35	0.04	1.44	560.92	8.83	0.04	1.57	1.81	5.75
2,884.36	681.12	4.48	23.61	5,501.06	1,125.25	4.54	20.46	8.13	6.75
136,499.83	15,212.70	100	11.14	211,693.69	24,775.33	100	11.70	11.11	6.44
89,800.02	10,338.43	67.96	11.51	141,952.58	15,688.54	63.32	11.05	11.86	5.50
46,699.90	4,874.27	32.04	10.44	69,741.10	9,086.79	36.68	13.03	9.65	8.26
2,522.39	667.24	4.39	26.45	5,131.02	1,096.89	4.43	21.38	8.24	6.67

Source: Data on horticultural products compiled by the author from various FAO sources.
Notes: Countries are listed in the order of their share of the world market in 1983-85 (in descending order).
n.a. means data were not available.

[a] Includes Eastern Europe and the U.S.S.R.

[b] Includes Asian centrally planned economies.

Table 45—Top four developing-country exporters of selected fruits, value of world trade more than US$50 million, 1983-85

Country	Bananas	Orange Juice	Orange Juice, Concentrated	Orange Juice, Single Strength	Tangerines	Lemons and Limes	Grapefruits/ Pomelo	Apples	Grapes	Raisins
Taiwan					x					
Argentina				x		x	x	x		
China										
Thailand										
Honduras	x									
Costa Rica	x									
Colombia	x									
Ecuador	x									
Morocco		x		x	x					
Cuba		x				x	x			
Egypt		x								
Cyprus		x				x	x			
Brazil			x							
Belize			x							
Singapore			x							
Jamaica			x							
Chile								x	x	x
Lebanon					x			x	x	
Turkey					x	x		x		x
Afghanistan									x	x
Cyprus									x	
Saudi Arabia										
Iran										x
Philippines										
Kenya										
Mexico				x						
Trinidad				x			x			
Pakistan										
Venezuela										
Iraq										
Tunisia										
Malaysia										
India										
Gaza Strip										
Jordan										
Côte d'Ivoire										
Martinique										
Peru										
Dominican Republic										
Hong Kong										
Korea, Republic of										
Sri Lanka										
Mozambique										
Tanzania										
Guinea-Bissau										
Kuwait										
					(percent)					
Share 1	93	36	81	14	24	24	43	20	31	39
Share 2	59	64	100	93	73	70	69	80	87	94

(continued)

Table 45—Continued

Country	Cashew nuts, Shelled	Fruits, Tropical N.E.S.	Fruits, Preserved N.E.S.	Fruits, Dried N.E.S.	Fruit Juice N.E.S.	Watermelons	Cantaloupes	Pears	Dates	Hazel nuts, Filberts	Coconuts, Desiccated
Taiwan		x	x	x							
Argentina			x					x			
China			x				x	x			
Thailand			x								
Honduras											
Costa Rica											
Colombia											
Ecuador											
Morocco											
Cuba											
Egypt					x	x					
Cyprus											
Brazil	x				x						
Belize											
Singapore								x			x
Jamaica											
Chile				x	x			x			
Lebanon											
Turkey							x			x	
Afghanistan											
Cyprus											
Saudi Arabia					x	x			x		
Iran				x					x	x	
Philippines											x
Kenya	x										
Mexico						x					
Trinidad											
Pakistan											
Venezuela		x									
Iraq									x		
Tunisia									x		
Malaysia		x									x
India	x	x									
Gaza Strip						x	x				
Jordan							x				
Côte d'Ivoire											
Martinique											
Peru											
Dominican Republic											
Hong Kong				x							
Korea, Republic of											
Sri Lanka											x
Mozambique	x										
Tanzania											
Guinea-Bissau											
Kuwait											
						(percent)					
Share 1	1	34	25	23	10	56	26	25	8	94	95
Share 2	99	78	43	70	57	87	74	87	100	100	100

(continued)

Table 45—Continued

Country	Hazelnuts, Shelled	Chestnuts	Cashew Nuts	Nuts N.E.S.	Almonds, Shelled	Pineapples	Pineapples, Canned	Pineapple Juice, Single Strength	Fruits, Fresh, N.E.S.
Taiwan									
Argentina									
China		x			x				
Thailand							x	x	x
Honduras						x			
Costa Rica									
Colombia									
Ecuador									
Morocco									
Cuba									
Egypt									
Cyprus					x				
Brazil						x		x	
Belize									
Singapore			x	x			x		
Jamaica									
Chile				x					
Lebanon									
Turkey	x	x			x				x
Afghanistan									
Cyprus									
Saudi Arabia									
Iran									
Philippines						x	x	x	
Kenya							x	x	
Mexico									
Trinidad									
Pakistan									x
Venezuela									x
Iraq									
Tunisia									
Malaysia					x				
India									
Gaza Strip									
Jordan									
Côte d'Ivoire						x			
Martinique									
Peru									
Dominican Republic									
Hong Kong		x	x	x					
Korea, Republic of		x							
Sri Lanka									
Mozambique									
Tanzania			x						
Guinea-Bissau			x						
Kuwait				x					
					(percent)				
Share 1	2	72	91	50	5	87	87	50	43
Share 2	99	98	100	82	100	84	81	87	69

Source: Data on horticultural products compiled by the author from various FAO sources.

Notes: Share 1 is the share of developing countries in the world market. Share 2 is the share of the top four exporters in total developing-country exports. The fruits selected are those with world trade valued at US$50 million or more. Countries are listed in the order of their share of the world market in 1983-85. N.E.S. is "not elsewhere specified."

Table 46—Top four developing-country exporters of selected vegetables, value of world trade more than US$50 million, 1983-85

	Vegetables										
Country	Fresh N.E.S.	Canned N.E.S.	Pre-pared, N.E.S.	Frozen	Dehy-drated	Tempo-rarily Pre-served	Toma-toes	Tomato Paste	Beans, Dry	Lentils	Pulses N.E.S.
Taiwan	x		x	x	x	x					
Mexico			x				x	x			
Hong Kong			x		x	x					
Morocco			x	x		x	x	x			
Turkey					x		x	x		x	
Jordan							x				
Thailand		x							x		x
Indonesia											
Costa Rica											
Dominican Republic											
Egypt				x	x						
Cyprus											
Lebanon											
Argentina									x		
China, People's Republic of	x	x							x		
Burma									x		
Korea, Republic of		x		x		x					
Brazil								x			
Venezuela	x										
Kenya	x										
Malaysia											x
Singapore		x								x	
India											
Sri Lanka											
Syria										x	
Chile										x	
Ethiopia											
Viet Nam											x
Pakistan											
						(percent)					
Share I	38	74	33	15	31	50	32	12	59	67	69
Share II	46	100	81	97	72	93	90	97	74	100	72

(continued)

Table 46—Continued

Country	Broad Beans	Chick-peas	Mushrooms Fresh	Mushrooms Canned	Mushrooms Dried	Potatoes	Onions, Dried	Garlic	Cucum-bers and Gherkins	Cabbages
Taiwan			x		x					x
Mexico		x						x	x	
Hong Kong										
Morocco	x					x				
Turkey	x	x					x			
Jordan									x	
Thailand										
Indonesia										x
Costa Rica										
Dominican Republic										
Egypt						x	x			
Cyprus						x			x	
Lebanon						x				
Argentina								x		
China, People's Republic of	x		x	x				x		x
Burma										
Korea, Republic of			x	x	x					
Brazil										
Venezuela										
Kenya										
Malaysia										
Singapore		x		x	x		x	x		x
India							x			
Sri Lanka										
Syria		x								
Chile										
Ethiopia	x									
Viet Nam										
Pakistan					x					
					(percent)					
Share I	58	67	35	36	45	18	31	72	1	17
Share II	100	97	100	100	96	65	61	77	100	

Source: Data on horticultural products compiled by the author from various FAO sources.

Notes: Share 1 is the share of the top four exporters in total developing-country exports. Share 2 is the share of the top four exporters in total developing-country exports. The vegetables selected are those with world trade valued at US$50 million or more. Countries are listed in the order of their share of the world market in 1983-85. N.E.S. is "not elsewhere specified."

APPENDIX 2: METHODOLOGY

Constant Market Share Analysis

A discrete two-time period model of constant market share analysis is presented below. The notations used are as follows:

$i = 1, \ldots, I$ = subscript for import market i;
0 = superscript indicating the base period;
1 = superscript indicating the end of the observation period;
Δ = change in a variable between two periods;
q_i^0 = exports to market i during the base period;
Q_i^0 = imports in market i during the base period;
s_i^0 = market share in market i during the base period; $s_i^0 = q_i^0/Q_i^0$.
q^0 = exports to all markets during the base period;
Q^0 = imports in all markets during the base period;
S^0 = market share of all markets during the base period; $S^0 = q^0/Q^0$.

If

$$q_i^0 = s_i^0 Q_i^0 \quad \text{and} \tag{1a}$$

$$q_i^1 = s_i^1 Q_i^1, \tag{1b}$$

and

$$s_i^1 = s_i^0 + \Delta s_i \quad \text{and} \tag{2a}$$

$$Q_i^1 = Q_i^0 + \Delta Q_i, \tag{2b}$$

then

$$\Delta q_i = q_i^1 - q_i^0 = s_i^1 Q_i^1 - s_i^0 Q_i^0. \tag{3}$$

Using equations (2a) and (2b) in (3),

$$\Delta q_i = s_i^0 Q_i^0 + s_i^0 \Delta Q_i + \Delta s_i Q_i^0 + \Delta s_i \Delta Q_i - s_i^0 Q_i^0, \tag{4a}$$

$$= s_i^0 \Delta Q_i + \Delta s_i Q_i^1. \tag{4b}$$

This is the decomposition of the total change in export value of the commodity with respect to one import market i. Summing equation (4b) over all import markets, $i = 1. \ldots, I$, yields:

$$\Delta q = \sum_i \Delta q_i = \sum_i s_i^0 \Delta Q_i + \sum_i \Delta s_i Q_i^1 \tag{5}$$

$$= (S^0 \Delta Q) + (\sum_i s_i^0 \Delta Q_i - S^0 \Delta Q) + (\sum_i \Delta s_i Q_i^1) \tag{6}$$

$$= \begin{matrix}\text{IMPORT GROWTH}\\ \text{EFFECT}\end{matrix} + \begin{matrix}\text{MARKET}\\ \text{EFFECT}\end{matrix} + \begin{matrix}\text{COMPETITIVE}\\ \text{EFFECT.}\end{matrix}$$

The import growth effect is the potential change in total exports of a country assuming a constant (base period) market share.

The market effect is the difference between the overall import growth effect $(S^0\Delta Q)$ and the sum of the market-specific growth effects $(\sum_i s_i^0 \Delta Q_i)$.

The latter term is determined by the magnitude of s_i^0 or ΔQ_i. Hence, for equal absolute changes (ΔQ_i), an important region (large s_i^0) affects $\sum_i s_i^0 \Delta Q_i$ more than a less important import region (small s_i^0). Also, under the constant market share in the base period, the sign and magnitude of the absolute change (ΔQ_i) determine the importance of a region's contribution to the market effect. Therefore, the market effect is likely to be negative under unfavorable import demand conditions in the most important regions.

The competitive effect is the residual after subtracting the import growth effect and the market effect from total change in exports. The competitive effect takes the change in market shares (Δs_i) explicitly into consideration. The severity of a market share loss in an important market $(-\Delta s_i)$ is proportional to the absolute size of the import market (Q_i^1).

Sources of Basic Data for Variables Used in Analysis of Factors Contributing to Differential Export Performance

Data sources are as follows:

RER (real exchange rate): A. Wood, *Global Trends in Real Exchange Rates, 1960 to 1984,* World Bank Discussion Paper 35, Washington, D.C.: World Bank, 1988, Appendix.

GDP (per capita real GDP): Nominal per capita GDP of each country in U.S. dollars was converted into domestic currency using the nominal official exchange rate and then deflated using the domestic CPI (1980 = 100) index. (All series were taken from World Bank, *World Tables,* various issues.)

Y (real income of exporting countries): International Monetary Fund, *International Financial Statistics,* various issues.

TDEP (openness of the economy): World Bank, *World Tables,* various issues.

LOAD (number of tons loaded in the ports of exporting countries): United Nations, *Statistical Yearbook,* various years.

EDU (the secondary school enrollment rate): World Bank, *World Tables,* various issues.

SMAN (the share of manufacturing goods in total exports): World Bank, *World Tables,* various issues.

PROD (the quantity of horticultural production): Food and Agriculture Organization of the United Nations, *FAO Production Yearbook,* Rome: FAO, various years.

Estimation of Elasticities

Empirical estimates of price elasticities of imports are not readily available for horticultural products. However, elasticities for broader levels of aggregation can give some idea about a more detailed line of items. In general, it is known that most of the import price elasticity estimates between products range between −0.5 and −1.5 for agricultural produce and between −0.75 and −2.75 for manufactured goods, while income elasticities tend to be higher (Stern, Francis, and Schumacher 1976). Where no estimates were available, Sarris (1983) assumed −0.5 for import elasticities and 2.0

for export elasticities. In the UNCTAD 1985 study, import demand elasticities for various horticultural products vary between –0.4 and –0.6.

Empirical estimates of import price elasticities are available for vegetable products (Cline et al. 1978, 58). Reported estimates are –0.90 for the United States, –0.47 for Japan, and –0.52 for the European Community.

Import demand and export supply elasticities can also be derived from the estimates of domestic demand and supply elasticities, the assumed share of imports in aggregate demand, and the share of exports in domestic production. Valdés and Zietz (1980) reported such estimates for selected horticultural commodities. Import demand elasticities estimated in that study ranged from –7.6 for potatoes to –0.4 for bananas, whereas the export supply elasticity estimates ranged from 8.9 for potatoes to 0.5 for grapes. Estimates obtained in this way tend to be high when the commodity is produced domestically because of assumed elasticity of substitution between the domestic and foreign markets. However, this latter assumption is not always true for all horticultural credits, especially if there is considerable production differentiation between domestic and export markets. Domestic price elasticities are also reported in a study by Hunt (1979).

Technical Description of the Simulation Model

The partial equilibrium simulation model is used in Chapter 5 to estimate the effects of a complete removal of tariffs and NTBs from major developed markets and the gains of developing countries.

The model employed is similar to those used by Zietz and Valdés (1986) and Laird and Yeats (1988). In these models, developing countries are expected to benefit from trade liberalization by combining two effects. First, the net exporting developing countries will gain from the increase in the world price resulting from trade liberalization, regardless of whether they increase their export quantity or not. Second, if developing countries have the capacity to increase exports readily in response to the world price increase, there is potential for an increase in the quantity of exports in developing countries.

Notations

P_j^0 = the preliberalization domestic price in the importing country j,
P_w^0 = the preliberalization world price,
E = the exchange rate,
t_j^0 = the preliberalization nominal protection coefficient in country j,
$\sim$ = percentage change,
m_j^0 = the preliberalization import in country j,
M = world imports,
x_i^0 = the preliberalization export from country i,
X = world exports,
e_j^m = the import demand elasticity in country j, and
e_i^x = the export supply elasticity in country i.

Model

In the preliberalization period, the domestic commodity price of country j (P_j^0) is related to the world market price (P_w^0) in the following way:

$$P_j^0 = P_w^0 \, E(1 + t_j^0).$$

Now, a tariff reduction by major developed countries is assumed to change each country's domestic price:

$$P_j^1 = P_w^1 \, E(1 + t_j^1),$$

where superscript 1 implies the postliberalization level of each variable. The exchange rate is assumed to be unaffected by the changes induced by trade liberalization.

Then, in final equilibrium, the percentage change in domestic price is

$$\tilde{P}_j = \Delta P_j / P_j^0 = (1 + \tilde{P}_w)\,[1 + \Delta t_j/(1 + t_j^0)] - 1.$$

Given the percentage change in the domestic price, the postliberalization level of imports is

$$m_j^1 = m_j^0(1 + e_j^m \tilde{P}_j)$$

or

$$\Delta m_j = m_j^0 e_j^m \tilde{P}_j .$$

Since it is assumed that tariffs are reduced simultaneously by all major developed markets, the total increase in world imports is

$$\begin{aligned}
\Delta M &= \sum_j \Delta m_j, \\
&= \sum_j m_j^0 e_j^m \tilde{P}_j, \\
&= \sum_j m_j^0 e_j^m \{(1 + \tilde{P}_w)\,[1 + \Delta t_j/(1 + t_j^0)] - 1\}, \\
&= \underbrace{\sum_j m_j^0 e_j^m [\Delta t_j/(1 + t_j^0)]}_{\substack{\text{increase in imports} \\ \text{assuming } P_w = P_w^0}} + \underbrace{\sum_j m_j^0 e_j^m \tilde{P}_w [1 + \Delta t_j/(1 + t_j^0)]}_{\substack{\text{reduction in imports by an} \\ \text{increase in world prices}}}.
\end{aligned}$$

Now consider the export supply side. An increase in export supply by an exporting country i is

$$\Delta x_i = x_i^0 e_i^x \tilde{P}_w ,$$

where x_i^0 is the preliberalization amount of exports from country i to liberalized developed markets. In the case of the European Community, which exports almost 90 percent of its total horticultural exports to itself, the increase in exports from the liberalization scenario will be relatively small due to the CAP, which implies that exportation within the European Community already faces free entry.

Equilibrium in the world market is achieved if the following equation holds:[41]

$$\Delta m_{EC} + \Delta m_{Japan} + \Delta m_{USA} = \Delta x_{EC} + \Delta x_{Japan} + \Delta x_{USA} + \Delta x_{LDC}.$$

Since the share of the rest of the developed countries in the world trade of horticultural products is small, they are ignored in our simulation. The equilibrium equation can be rewritten as

$$\sum_j m_j^0 e_j^m [\Delta t_j/(1 + t_j^0)] + \tilde{P}_w \sum_j m_j^0 e_j^m [1 + \Delta t_j)(1 + t_j^0)] = \tilde{P}_w \sum_i x_i^0 e_i^x.$$

Then the equilibrium $\tilde{P}_w$ can be expressed as

$$\tilde{P}_w = \frac{\sum_j m_j^0 e_j^m [\Delta t_j/(1 + t_j^0)]}{\sum_i x_i^0 e_i^x - \sum_j m_j^0 e_j^m [1 + \Delta t_j/(1 + t_j^0)]}.$$

Substituting this expression for $\tilde{P}_w$ into Δm_j gives

$$\begin{aligned}\Delta m_j &= m_j^0 e_j^m [\Delta t_j/(1 + t_j^0)] + m_j^0 e_j^m \tilde{P}_w [1 + \Delta t_j/(1 + t_j^0)] \\ &= m_j^0 e_j^m [\Delta t_j/(1 + t_j^0)] \\ &\quad + \left[\frac{\sum_j m_j^0 e_j^m [\Delta t_j/(1 + t_j^0)]}{\sum_i x_i^0 e_i^x - \sum_j m_j^0 e_j^m [1 + \Delta t_j/(1 + t_j^0)]}\right] m_j^0 e_j^m [1 + \Delta t_j/(1 + t_j^0)].\end{aligned}$$

The expression for $\tilde{P}_w$ can be simplified by using weighted averages of e_j^m, e_i^x, and t_j:

$$\tilde{P}_w = \frac{e_w^m [\Delta t_w/(1 + t_w^0)] \sum_j m_j^0}{e_w^x \sum_i x_i^0 - e_w^m [1 + \Delta t_w/(1 + t_w^0)] \sum_j m_j^0}.$$

Since

$$\sum_j m_j^0 = \sum_i x_i^0,$$

$$\tilde{P}_w = \frac{e_w^m [\Delta t_w/(1 + t_w^0)]}{e_w^x - e_w^m [(1 + \Delta t_w/(1 + t_w^0)]},$$

$$= \frac{[\Delta t_w/1 + t_w^0)]}{(e_w^x/e_w^m) - [1 + \Delta t_w/(1 + t_w^0)]},$$

---

[41] In a new equilibrium, imports of developing countries will also adjust to a new world price. However, this change is abstracted from this analysis because it unnecessarily complicates the analysis.

where

$$e^x_m = \sum_i (x_i/\sum_i x_i)e^x_i,$$

$$e^m_w = \sum_j (m_j/\sum_j m_j)e^m_j, \text{ and}$$

$$t_w = \sum_j (m_j/\sum_j m_j)t_j.$$

Furthermore, if it is assumed that

$$e^m_j = e^m \text{ for all } j,$$

$$e^x_i = e^x \text{ for all } i, \text{ and}$$

$$t_j = t \text{ for all } j,$$

$$\Delta m_j = m^0_j e^m[\Delta t/(1 + t^0)] + \left(\frac{[\Delta t/(1 + t^0)]}{e^x/e^m - [1 + \Delta t/(1 + t^0)]}\right) m^0_j e^m[1 + \Delta t/(1 + t^0)]$$

$$= m^0_j e^m[\Delta t/(1 + t^0)] \left(1 + \frac{[1 + \Delta t/(1 + t^0)]}{e^x/e^m - [1 + \Delta t/(1 + t^0)]}\right)$$

$$= m^0_j e^m[\Delta t/(1 + t^0)] \left(\frac{1}{1 - (e^m/e^x)[1 + \Delta t/(1 + t^0)]}\right).$$

This expression is similar to the one presented in Laird and Yeats (1988).

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